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GUIDELINES FOR DEVELOPMENT OF CRITERIA FOR CONTROL OF OCEAN WASTE DISPOSAL

INTERSTATE ELECTRONICS CORPORATION

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

FEBRUARY 1974

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Report No. 4460C1543
June, 1973
*PB 224 459/AS, $3.50 paper, $1.45 MF

A BIBLIOGRAPHY ON OCEAN WASTE DISPOSAL
Report No. 4460C1542
May, 1973
*PB 224 452/AS, $4.25 paper, $1.45 MF

OCEAN WASTE DISPOSAL IN SELECTED GEOGRAPHIC AREAS
Report No. 4460C1541
July, 1973
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OCEAN WASTE DISPOSAL IN THE NEW YORK BIGHT
Report No. 4460C1559
August, 1973
*PB 224 983/7AS, $4.50 paper, $1.45 MF

AN ATLAS OF OCEAN WASTE DISPOSAL SITES
Report No. 4460C1545
September, 1973

OCEAN WASTE DISPOSAL PRACTICES IN METROPOLITAN AREAS OF CALIFORNIA
Report No. 4460C1635
February, 1974

NAVIGATION AIDS FOR OCEAN WASTE DISPOSAL CONTROL
Report No. 4460C1629
February, 1974

*These reports are available through the National Technical Information System, U.S. Department of Commerce, Springfield, Virginia 22151.

INTERSTATE
ELECTRONICS
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Environmental Engineering Division
(Formerly OceanicS Division)

REPORT 4460C1544

FEBRUARY 1974

GUIDELINES FOR DEVELOPMENT OF CRITERIA FOR CONTROL OF OCEAN WASTE DISPOSAL

Prepared for the

U.S. ENVIRONMENTAL PROTECTION AGENCY
OCEAN DISPOSAL PROGRAM
Under Contract 68-01-0796

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FOREWORD

In February of 1973, a research investigation entitled "Development of Criteria for Ocean Waste Disposal" was contracted to Interstate Electronics Corporation (IEC). This contract, 68-01-0796, under the auspices of the Ocean Disposal Program of the U. S. Environmental Protection Agency, was to assemble information to assist in the development of permit criteria for the control of ocean waste disposal.

The Environmental Engineering Division of IEC, initiated a multifaceted study which included conventional research and actual field surveys of ocean disposal practices in six geographical areas. Information on factors that directly affect the development of future criteria included:

- The geographic locations of disposal sites.
- The physical characteristics of disposal sites including water depth, bottom geology, benthic species, and physical oceanography.
- The length of time the sites have been used.
- The type, the amount, and the composition of the dumped material.
- The frequency of the dumping operation and method of disposal.
- Evaluation of the existing water quality, and currently used monitoring procedures.

The information obtained has been presented in a series of reports which provide the rationale for the present EPA ocean dumping criteria as well as site selection for ocean disposal. This study of ocean waste disposal was made possible only by a high degree of cooperation that was received from the federal and state personnel and employees of private industry who contributed to this effort. We would like to express special appreciation to the following agencies and individuals:

446OC1544

The U. S. Environmental Protection Agency Ocean Disposal Branch; T. A. Wastler, Chief, and his scientific staff, including in particular William Musser and BarBara Wygal.

The U. S. Army Corps of Engineers District Offices in New York; Charleston, South Carolina; Mobile, Alabama; Galveston, Texas; Los Angeles-San Francisco, California; and Seattle, Washington.

The U. S. Environmental Protection Agency Regional Administrators in Region II, IV, VI, IX and X.

The National Oceanic and Atmospheric Administration.

The reports that comprise the study, and the files for electronic data processing systems, were produced by the scientific and technical staff of the Environmental Engineering Division of Interstate Electronics Corporation under the Project Management of Mr. S. Kelly.

I would like to take this opportunity to encourage readers of the report to communicate their comments and suggestions directly with personnel that worked on specific aspects of the study.

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Section 1

AN INTRODUCTION TO THE OCEAN DISPOSAL STUDY

1.1 SCOPE OF STUDY

Public Law 92-532, "Marine Protection, Research and Sanctuaries Act" of October 23, 1972, prohibits dumping material into the territorial sea or the contiguous zone of the United States without a federal permit. This statute and the "Federal Water Pollution Control Act Amendments of 1972" (PL 92-500), were enacted in response to public concern over the quality of water. These statutes strengthened and modified earlier bills such as the "Federal Water Pollution Control Act of 1956" (PL 84-660), the "Water Quality Act of 1965" (PL 39-235), the "Clean Water Restoration Act of 1966" (PL 89-735) and the "Water Quality Improvement Act of 1970" (PL 91-224).

In carrying out the responsibilities and authority conferred by PL 92-532, the Administrator of the U.S. Environmental Protection Agency (EPA) "shall establish and apply criteria for reviewing and evaluating permit applications" (PL 92-532, Sec. 102). Section 103 authorizes the U.S. Army Corps of Engineers to issue permits for transportation and dumping of dredged material (spoil). Permits issued "shall designate and include (1) the

type of material authorized to be transported for dumping or to be dumped, (2) The amount of material authorized to be transported for dumping or to be dumped; (3) the location where such transport for dumping will be terminated or where such dumping will occur" (Refer to PL 92-532, Sec. 104 for further permit conditions). Restrictions are imposed to insure that the dumping will not unreasonably degrade or endanger human health, welfare or amenities or the marine environment, ecological systems or economic potentialities. In addition to the above, significant amendments were made to the Federal Water Pollution Control Act (PL 92-500) and the U.S. Government signed an international agreement which was ratified by the U.S. Senate in August of 1973 as the "International Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter".

Early in 1973, the EPA established the Ocean Disposal Program (ODP). This organization immediately published an interim criteria, "Guidelines for the Application of Regulations and Criteria for the Regulation of Dumping, or Transportation for Dumping of Waste Materials into the Ocean in Order to Prevent Degradation of the Marine Environment". Existing disposal sites were assigned interim status. To ensure that the final criteria would be based on conclusive information, the ODP initiated a program to "develop criteria to control ocean dumping". The goal was to collect information and supporting documentation that

"shall provide the rationale for the final criteria as well as site selection for ocean disposal". A contract was negotiated with Interstate Electronics Corporation (IEC) Oceanics Division (now Environmental Engineering Division), to perform a special study, the purpose of which was to assist the ODP in the development of the final criteria. The end product of this study was a series of technical reports (see inside back cover) covering the various phases of ocean waste disposal.

1.2 HISTORICAL BACKGROUND OF CONTRACT

During a previous contract with the EPA, Water Quality Protection Branch, Division of Water Quality and Non-Point Source Control, IEC collected extensive information concerning the location of disposal sites, the characteristics of the material dumped, and the management control of the sites. This information was presented in IEC. Report 445-A, A National Overview of Existing Coastal Water Quality Monitoring, December 1972.

Pursuant to the ODP contract, this existing data bank was updated and expanded. Information was gathered from many sources but the most reliable, accurate and up-to-date information came from an intensive survey of six coastal areas of the United States: the New York Bight; Charleston, South Carolina; the Gulf Coast between Port St. Joe, Florida and Port Isabel, Texas; Southern

California; San Francisco; and Puget Sound. These areas, shown in Figure 1-1, include climatic zones from sub-tropical to temperate. The variety of dumped material ranges from acid to wrecks. Field interviews were conducted in these areas to determine how the existing disposal sites were selected, what criteria were used to determine the site boundaries, the types and quantities of disposed waste, what surveillance methods were used and what studies were being performed to determine environmental effects.

In addition to the report on the selected geographic areas, a directory of individuals concerned with ocean dumping, a bibliography, and an atlas of disposal sites were compiled. These reports are summarized in the next subsection. The remaining sections of this report present an evolutionary development of guidelines for ocean dumping criteria.

1.3 SUMMARY OF OCEAN WASTE DISPOSAL STUDY

1.3.1 Directory

During the previous study of coastal zone water quality monitoring, more than 1,500 managers, engineers and scientists that were involved in water quality monitoring were contacted. A name and address file was originated, maintained, and used for that project. To facilitate updating and retrieval of the file,

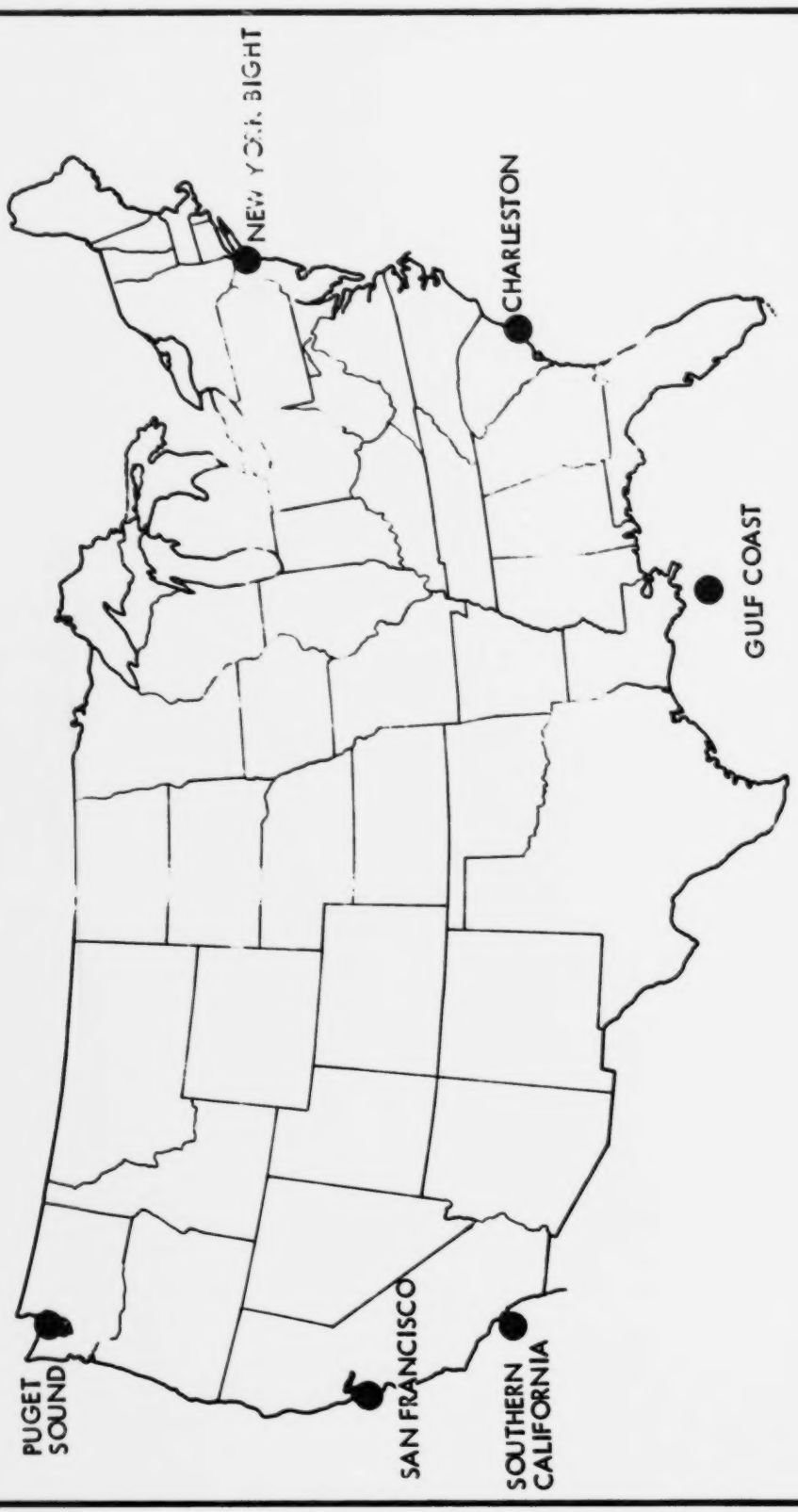

FIGURE 1-1 OCEAN DISPOSAL CASE STUDY AREAS

IEEC INTERSTATE ELECTRONICS CORPORATION

a computer system was established using the name/address feature of the Word/One Computer Service (Bowne Timesharing, Inc.). A standard input form was designed for entering names, addresses, and other pertinent data into the computer master file. Project personnel submitted new data for permanent storage, and current data to update the file. Obsolete data were deleted on a periodic basis utilizing a Datel 30 low-speed terminal, shown in Figure 1-2.

FIGURE 1-2 DATA INPUT TERMINAL

To respond quickly to EPA under the ocean waste disposal study, this existing master file was sorted to generate a list of individuals involved in ocean dumping activities. This retrieval

of key names established a special ocean dumping contact list which was used for telephone interviews and for initial contacts during the field survey. The field survey team subsequently contacted an extensive number of additional individuals who are working on ocean disposal problems or in closely associated environmental science fields. Realizing that communications are a major problem, the Ocean Disposal Program commissioned the assembling of a directory. This directory was prepared from the updated and expanded master computer file and published as Report 4460C1543, Directory of Managers, Engineers and Scientists in Ocean Waste Disposal and Related Environmental Science Fields. Distributed copies were provided with data entry forms for additions, corrections and suggestions. Forms returned will be considered by EPA for incorporation into subsequent issues. Figure 1-3 is a montage of the name/address form.

1.3.2 Bibliography

In conjunction with the computer processing of the directory, the Word/One computer system was used to compile a bibliography of current, critical documents pertaining to ocean disposal. The file contains coded listings of two classifications--those available in the IEC Engineering library, and those collected during the field survey. The literature search was assisted by information from many federal agencies.

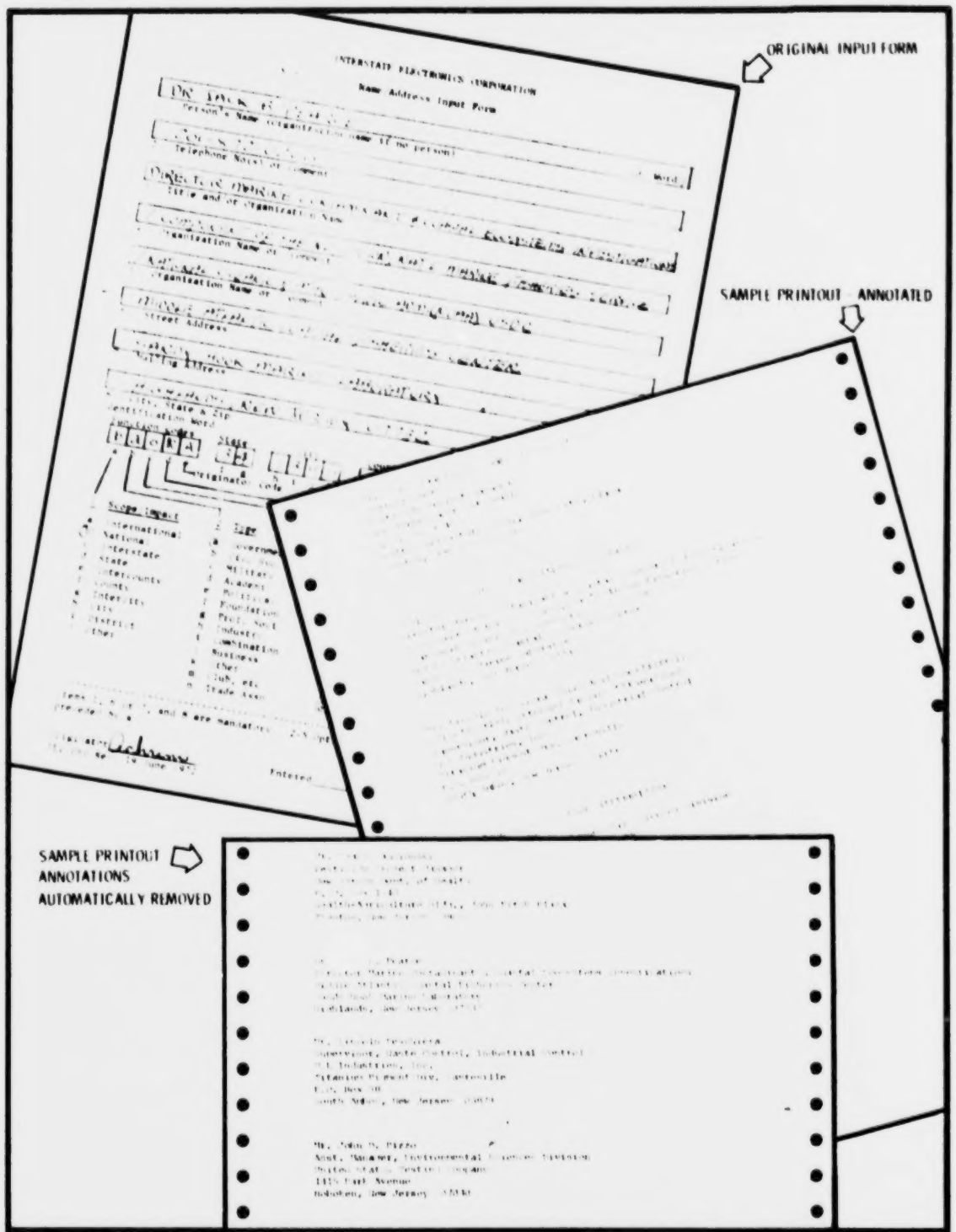

FIGURE 1-3

MONTAGE

NAME/ADDRESS FORM

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Over 400 documents were accessioned (74 abstracted) and published as Report 4460C1542, A Bibliography on Ocean Waste Disposal. This research bibliography was primarily limited to recent publications (1968 to 1973). As with any interim document, omissions will occur. To facilitate the incorporation of new documents, and for corrections, computer entry forms were provided in each document distributed. The final document will be available on a computerized retrieval system permitting recovery by a wide range of key words and descriptors derived from the "Thesaurus of Water Resources Terms" (1971). Figure 1-4 is a montage of the bibliography forms.

1.3.3 Atlas

The study included preparation of Report 4460C1545, An Atlas of Ocean Waste Disposal Sites. It contains detailed navigational quality charts for each of the disposal sites listed in the Federal Register, May 16, 1973. Chart coordinates, site areas, authorized material types, navigation aids, and primary site management agencies are listed. It also contains sections on nautical chart symbols and abbreviations, and electronic navigation aids that apply to ocean waste disposal control.

The EPA Interim Criteria & Regulations were designed to be amended to meet changes in technology, national policy and priorities, and even physical geography. Therefore, the Atlas

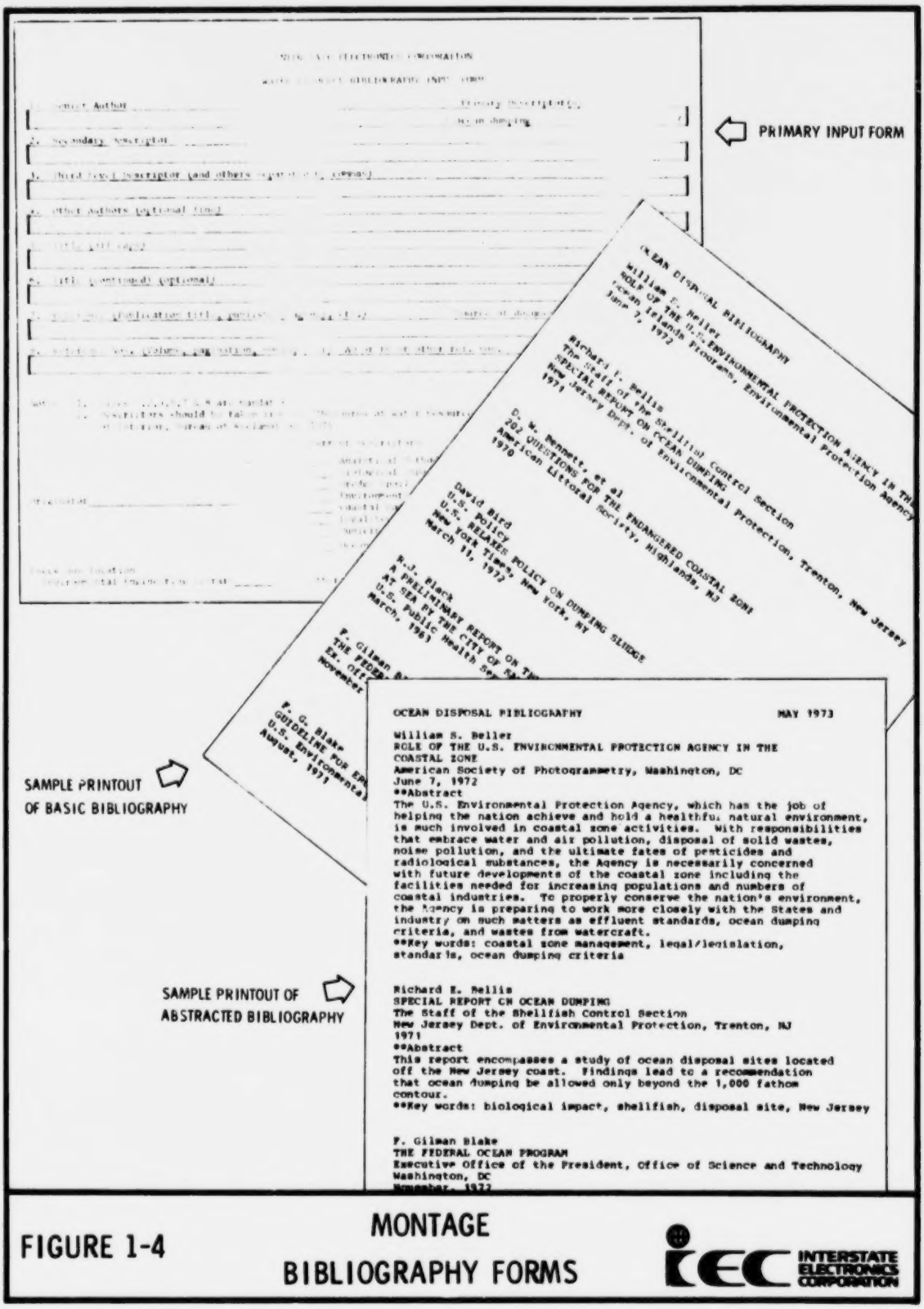
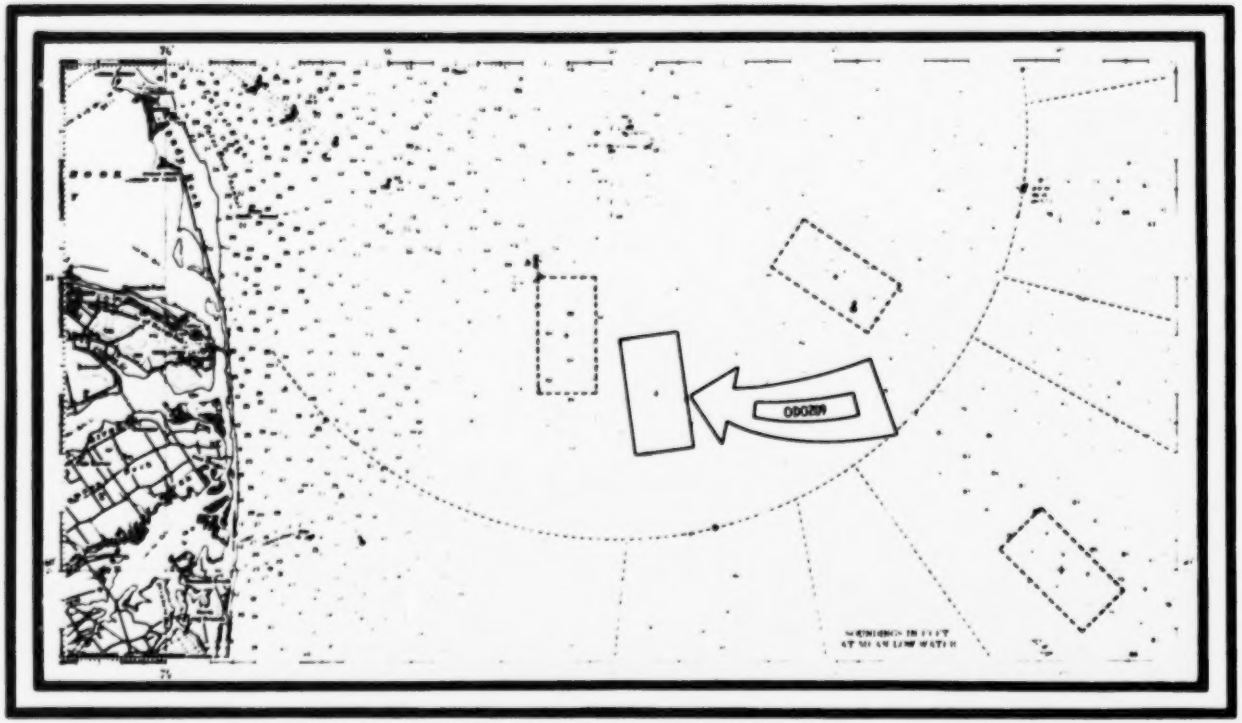

PRIMARY INPUT FORM
SAMPLE PRINTOUT OF BASIC BIBLIOGRAPHY
SAMPLE PRINTOUT OF ABSTRACTED BIBLIOGRAPHY
OCEAN DISPOSAL BIBLIOGRAPHY MAY 1973
William S. Beller
ROLE OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY IN THE COASTAL ZONE
American Society of Photogrammetry, Washington, DC
June 7, 1972
**Abstract
The U.S. Environmental Protection Agency, which has the job of helping the nation achieve and hold a healthful natural environment, is much involved in coastal zone activities. With responsibilities that embrace water and air pollution, disposal of solid wastes, noise pollution, and the ultimate fates of pesticides and radiological substances, the Agency is necessarily concerned with future developments of the coastal zone including the facilities needed for increasing populations and numbers of coastal industries. To properly conserve the nation's environment, the Agency is preparing to work more closely with the States and industry on such matters as effluent standards, ocean dumping criteria, and wastes from watercraft.
**Key words: coastal zone management, legal/legislation, standards, ocean dumping criteria
Richard E. Bellis
SPECIAL REPORT ON OCEAN DUMPING
The Staff of the Shellfish Control Section
New Jersey Dept. of Environmental Protection, Trenton, NJ
1971
**Abstract
This report encompasses a study of ocean disposal sites located off the New Jersey coast. Findings lead to a recommendation that ocean dumping be allowed only beyond the 1,000 fathom contour.
**Key words: biological impact, shellfish, disposal site, New Jersey
F. Gilman Blake
THE FEDERAL OCEAN PROGRAM
Executive Office of the President, Office of Science and Technology
Washington, DC
November, 1972

FIGURE 1-4 MONTAGE BIBLIOGRAPHY FORMS

has been formatted to be readily revised. Requests for revisions such as area reductions, site shifts, rotations or shape changes to the presently charted sites may be approved rapidly; but expansions, major relocations, or reinstatement of older inactive sites will require investigation prior to EPA approval or denial. It is planned that the chart index will be updated periodically. Revised copies will be sent to all registered users of the Atlas. Figure 1-5 shows the preparation of a charted site and Figure 1-6 is a typical chart, Site No. OD0212.

FIGURE 1-5 PREPARATION OF SITE CHART

U.S. ENVIRONMENTAL PROTECTION AGENCY
Ocean Disposal Program Office



Center Coordinates	40° 23' 00" N, 73° 49' 00" W
Area	2.0 Square Nautical Miles
Navigation Chart No.	NOS 1215
Local Navigation Aids	Decca, Loran A & C, Omega, RDF, CG Radar
Material Type	Cellar Dirt
Primary Management	EPA

INTERIM DISPOSAL SITE

September 1973

SITE NO. ODO209

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FIGURE 1-6 TYPICAL CHART

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4460C1544

1.3.4 Field Studies

Studies of ocean waste disposal practices in six geographical areas of the United States were conducted. The findings of the field investigation phase of the study were published as Report 4460C1541, Ocean Waste Disposal in Selected Geographic Areas. Highlights from that report are presented, by area, in the following paragraphs:

1.3.4.1 New York Bight - Six separate dumping grounds in the Atlantic Ocean are designated for the disposal of mud and one-man stone, cellar dirt, sewage sludge, wrecks, waste acid, and chemical (toxic) wastes. The locations of these sites, and the major significant ecosystem alterations (shellfish closures) are shown in Figure 1-7. During the period from July 1, 1972 to February 28, 1973, the U.S. Army Corps of Engineers (COE) New York District, Supervisor of New York Harbor, issued 349 dumping permits which authorized 12,160,464 cubic yards of material to be dumped in the designated areas. These figures are from the COE Statement of Activities which is based on the fiscal year beginning July 1 and ending June 30. Data extracted from their files for the year 1972 (January - December) indicated a total of 463 permits were issued. One hundred eighty-six permits were returned by the towing companies who certified that a total of 4,870 trips were made to the designated dumping areas where 15,728,560 cubic yards of material were dumped.

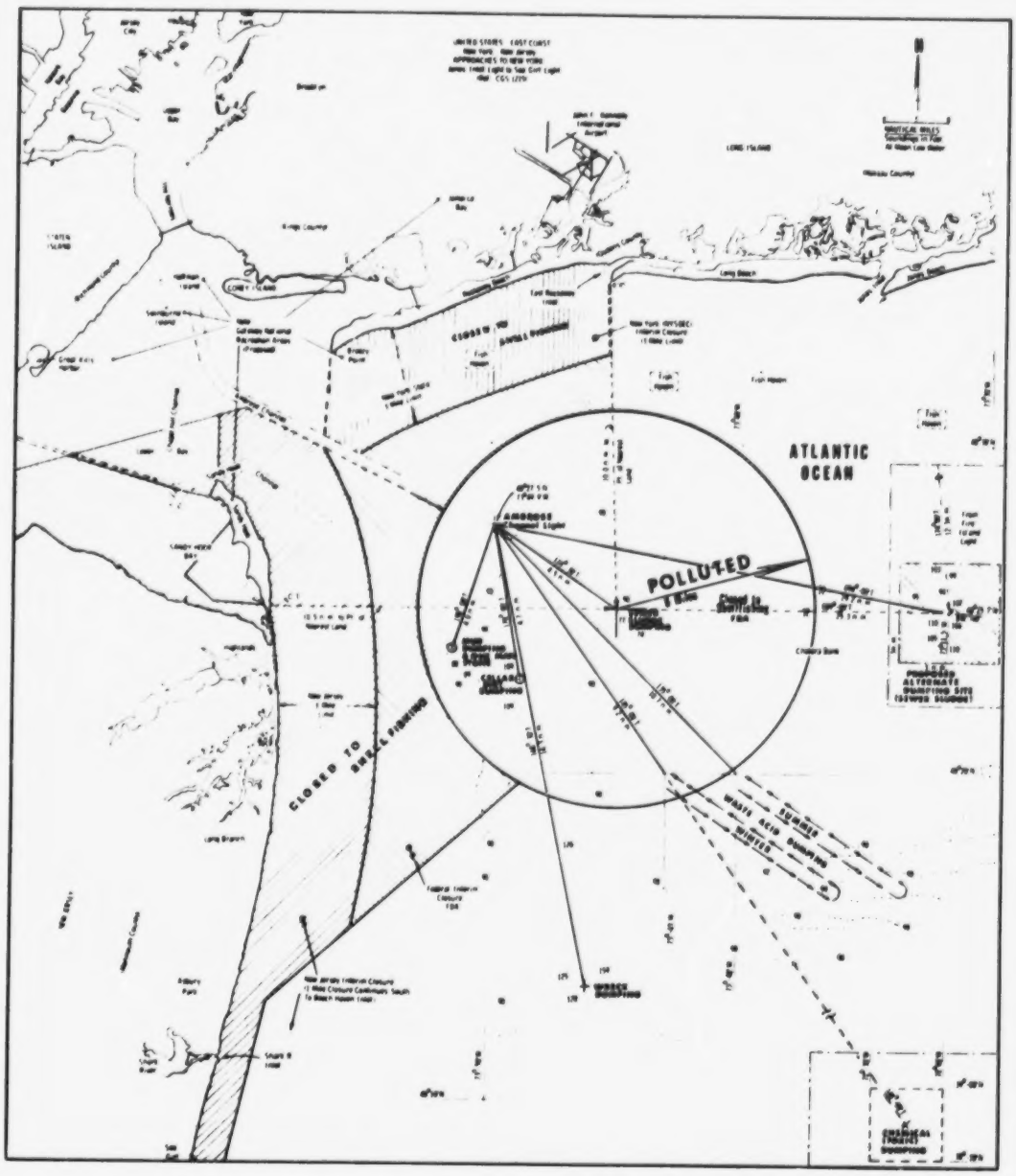

FIGURE 1-7 NEW YORK BIGHT DISPOSAL SITES

Ocean dumping is believed to be occurring in locations other than the prescribed dump areas. The extent and type of the violations are not known because of the present lack of a suitable monitoring system. Early (short) dumping is attributable to rough seas, inclement weather, and possibly faulty navigation. Figure 1-8 is an enlargement of a NASA Earth Resources Technology Satellite (ERTS) image of the New York Bight, which shows evidence of a short dump. The arrows point to the designated dump sites, number 1 is the Waste Acid Site, number 2 is the Sewage Sludge Site.

1.3.4.2 Charleston, South Carolina - The survey centered around the Harbor of Charleston, which is a primary source of income to the city and surrounding areas. Harbor dredging is of major importance to the economy, and ocean disposal of dredge spoil has been done since 1875; however, the quantities were minor until the Santee-Cooper River project was completed in 1942. Dredging requirements increased rapidly to the current 10 million cubic yards per year.

The dredge spoil disposal ground is located in proximity to the ship channel; the closest point being 1.5 nautical miles. Boundaries of the disposal zone were not fixed and no ocean limits set; therefore, no positive control of disposal operations were possible.

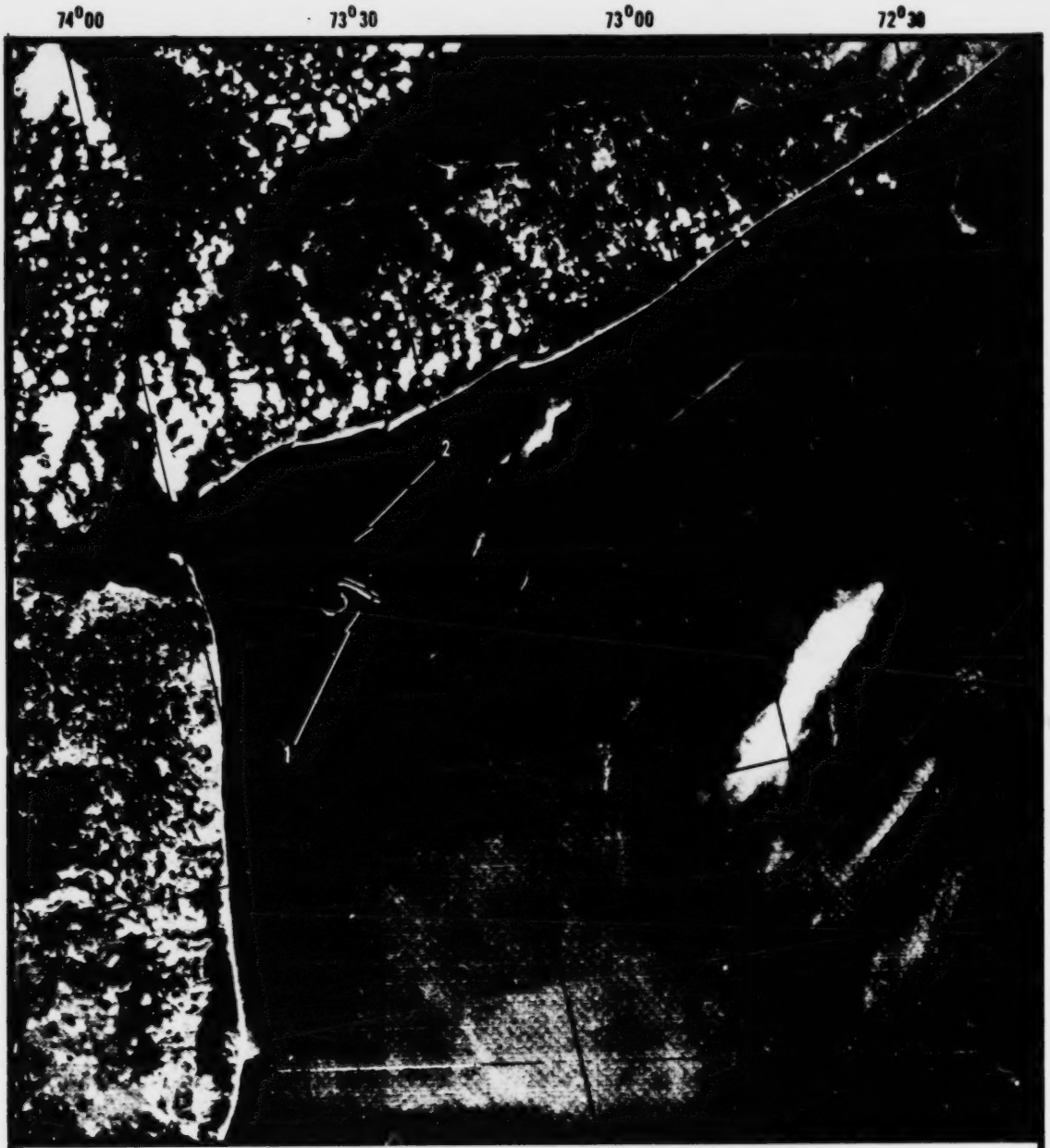

FIGURE 1-8 ERTS-1 IMAGE

For the current volume and makeup of the ocean waste disposal materials, there are no immediate problems associated with disposal at the site now being used. However, contaminated dredge spoil from the inner harbor may have adverse environmental effects if disposed in the ocean.

1.3.4.3 Gulf Coast - The geographical area covered by this survey is the continental shelves and slopes bordering the Gulf of Mexico, from Port St. Joe, Florida to Port Isabel, Texas. This area coincides with the areas of dredging controlled by the Mobile, New Orleans, and Galveston District Offices of the U.S. Army Corps of Engineers.

Waste disposal within the survey area is primarily dredge spoil and chemicals. Currently, 40 million tons of dredge spoil are dumped annually at 33 near-shore sites from three hopper dredges operated by the Corps of Engineers.

1,161,000 tons of chemicals by bulk, and 6,650 tons in 55-gallon drums (500 pounds) are disposed of annually at two deepwater sites designated for industrial wastes. It is known that some of this material is commonly dumped short of these sites. There are reports of explosion injuries and chemical burns resulting from inadequately weighted drums that float ashore or are collected in

the nets of shrimp trawlers. At the time of the study, there had been no environmental monitoring conducted at either site.

1.3.4.4 Southern California - The Los Angeles and San Diego metropolitan areas use the ocean waters of Southern California for waste disposal. Materials dumped in the past and now prohibited are: explosives, radioactive wastes, refinery wastes, oil drilling wastes, and filter cake (a residue of algin extraction from locally harvested kelp). Present dumping is concentrated in two areas south of Los Angeles. These sites are used for the disposal of trash and garbage, industrial wastes, and miscellaneous wastes--usually telephone slugs, contraband weapons and deactivated ammunition. Ocean pipeline disposal of treated sludge is used by Los Angeles and Orange counties. The Hyperion Plant in Los Angeles pumps approximately 5 million gallons per day of sludge to the ocean via a seven mile long outfall. Because pipeline disposal is a point source, the details were omitted in this report, but are included in the case study report (IEC 445-B9) of the previous contract (Section 1.2).

Since 1931, approximately 51,000 tons of trash and garbage have been collected from commercial vessels in Long Beach and San Pedro Harbors and dumped southeast of Santa Catalina Island. Present annual disposal is 623 tons. A site 9.2 nautical miles north of Catalina Island is used for the disposal of industrial

waste by-products, some characterized as extremely noxious. A three-year summary indicated that 1,172,667 pounds of these materials were dumped at this site.

Although the Southern California area is the home of major oceanographic laboratories and has many institutions engaged in ocean research, the existing disposal sites have not been specifically studied.

1.3.4.5 San Francisco - San Francisco's long history of ocean dumping has been under close scrutiny by local and state regulatory agencies in recent years. As a result of the local activities, most ocean dumping has stopped either by direct regulation or by monetary pressures and environmental concern.

The materials dumped offshore in the past have been refinery wastes, acid wastes, cannery wastes, radioactive wastes, munitions, and dredge spoil. The present dumping activities in the San Francisco area are limited to two dredge spoil sites, both under the U.S. Army Corps of Engineers administration.

One site is used for the disposal of material dredged from the main ship channel west of the Golden Gate bridge. Approximately 600,000 cubic yards of dredge spoil is dumped annually. The site is on a submerged sand bar which extends in an arc outside the

Golden Gate at a distance of about five miles. It is 3,000 feet south of the main ship channel and about 5,000 yards long and 1,000 yards wide. Water depths range from 36-50 feet. A proposed 55-foot main ship channel depth would increase the depth of the site to 7000 yards with annual maintenance quantity of 900,000 cubic yards (projected).

The Army Corps of Engineers have conducted studies on the effects of the dredging and maintain a line of communication with all federal and state agencies. Continuous monitoring is not conducted. Samples of the dredge spoil are collected on an irregular basis during operations.

Recommendations have been made for a long-term study of the dredge channel and disposal site, including mandatory monitoring. Dredging would be scheduled during periods of the year that are less damaging to benthic life.

1.3.4.6 Puget Sound - The geographical area covered by this survey is the waters of the Strait of Juan de Fuca, Puget Sound, and the interconnecting inlets and adjacent bays south and east of the Canadian boundary.

Although there are many outfalls discharging municipal and industrial wastes in the waters of Puget Sound, only dredge spoil

are transported and dumped by vessels at near-shore sites. A barging operation takes refuse from Seattle to a shoreside landfill on the Tulalip Indian Reservation north of Everett. An industrial chemicals company annually dumps 225,000 tons of vanillin black liquor in the Strait of Juan de Fuca. An explosive disposal site is located 80 miles west of Cape Flattery, but has not been used since 1970. Approximately 250,000 cubic yards of dredge spoil are dumped annually at twelve sites designated by the State of Washington, Department of Natural Resources.

Considerable data is available on the discharging of industrial wastes into Puget Sound via outfalls, but there is no public information on the waste vanillin black liquor dumping operations. There have been two meaningful studies in Puget Sound on the effects of dredging and spoil disposal at shallow sites. It was recommended that a comprehensive study be conducted on the effects of spoil disposal at one of the presently approved deepwater sites. The study should include monitoring of physical, chemical, biological, and geological oceanographic parameters for a period of at least one year at both the site and a nearby control area of similar character. Monitoring of both areas should continue after dumping operations for a minimum of two years to evaluate the concept of concentrating spoil disposal at a small site in deep waters (by

comparison with the previous shallow site studies) and to determine net changes resulting from spoil disposal at such a site by comparison with the nearby control area.

1.4 CONCLUSIONS AND RECOMMENDATIONS

As a result of our studies, we conclude that ocean disposal of wastes will continue to increase in the future unless technological breakthroughs occur in the economic recycling of these misplaced natural resources. Although it may be temporarily necessary to apply restrictions and sanctions to reduce the degradation of the marine environment by pollution, the long term cure must come from the recovery and reuse of these wasted sources of metals, fuels, fibers, chemicals, soil conditioners and fresh water. Thus, our basic recommendation is to emphasize a positive policy of supporting and encouraging research in the technology of resource reclamation while minimizing the negative "thou shalt not" approach of control by edict and decree. Alternate methods of disposal for virtually all waste except polluted dredge spoil exists. However, the economic factors of transportation costs by rail or truck, capital expenditures for landfill areas or incineraters and energy requirements to use these alternates will result in pressures to use the oceans as disposal sites. Most of these alternates are also objectionable from an aesthetic standpoint

and may cause greater air, land, and water pollution problems than ocean disposal.

The following projections of increases in volumes of the various waste types disposed in the ocean are based upon current trends and do not reflect any new reclamation processes or major changes in present disposal techniques. By comparison, coastal population is increasing at an annual rate of 1.5%, and industrial production is increasing 4.5% annually.

Solid wastes - because of the reduction in availability of land-fill sites and restrictions to protect air and ground water quality, ocean dumping of garbage, trash and construction debris is expected to increase 17% annually.

Sewage sludge - because of increased use of metropolitan collection and treatment facilities by both industry and septic tank users and the greater efficiency of solids removal by advanced treatment processes, ocean disposal of this waste is estimated to increase 5% annually.

Industrial wastes - because of increased recycling of acids and caustics, ocean dumping of this class of waste is declining in volume. However, the remaining chemical wastes are both more complex and more concentrated. Thus the volumes of sea water

required for dilution and biodegradation to sub-toxic levels are estimated to remain static.

Conventional munitions - alternate methods of disposal are now used for explosives and no further ocean dumping of significant volume is expected. This waste category was the most innocuous and had the least environmental impact.

Dredge spoil - Because of the economic advantages of larger cargo vessels, there is pressure to deepen ports and channels. Maintenance dredging at one-fourth of the present intermediate depth ports will increase by 40% annually. The national annual increase in ocean dumping of spoil is estimated at only 8% because more of this material will be used for beach replenishment and development of wildlife habitat. Spoil quality may improve because of stricter regulation of waste discharges into harbors and navigable waterways.

Radioactive wastes - the present moratorium on ocean dumping of high-level wastes is expected to remain in effect for the next 15 years. In the same period, there will be a great increase in the number of nuclear power generating plants, nuclear powered ships, and small isotope powered thermoelectric sources for remote weather stations, lighthouses, buoys, etc. Beginning about 1990 there will be a sudden increase in the number of obsolete devices

and unless recycling or conversion techniques are developed, the pressure to use the ocean deeps for disposal will be immense because of the cost, and both real and imaginary hazards of land disposal.

In summary, our findings indicate that total volumes of material being dumped in the ocean are increasing five times more rapidly than the general population. Pressures will be exerted in the future to relax certain restrictions on ocean disposal. It is our recommendation that an adequate body of knowledge be assembled to provide for immediate control of present waste disposal problems and for evaluation of future disposal needs. To achieve this end we have formulated the following recommendations:

1. That the Ocean Disposal Program implement a system for total ocean waste load inventory. This system would consolidate selected information from the National Pollutant Discharge Elimination System, the U.S. Army Corps of Engineers dredge spoil permit operations, the U.S. Geological Survey Office of Water Data Coordination, and data from EPA Regional permits. This information would be organized on a river basin basis so that total impact of pollutants on specific oceanic areas can be determined.

2. That the Ocean Disposal Program initiate a series of baseline surveys for all ocean disposal sites. Consolidation of neighboring sites may be done for economy. These surveys would be designed to produce a comprehensive physical, chemical, biological, and geographic data base for each site area.

3. That the Ocean Disposal Program support the establishment of an inter-agency ecological research and monitoring program. This program would coordinate the efforts of various government agencies with a goal of establishing the impact of ocean dumping operations on:

   (a) Public health.

   (b) Fisheries and the supporting food chains.

   (c) Coastal wildlife.

   (d) The origins and ultimate fates of pollutants.

   (e) The introduction and persistence of toxic substances.

   (f) Recreation economics and esthetics.

   Under this program, the Ocean Disposal Program would become a major source and user of physical, biological, and chemical oceanographic data.

4. That the Ocean Disposal Program continue to update their information storage, retrieval, exchange, and

dissemination capability in order to maintain the most effective liaison with all levels of government, academic institutions, commercial associations and a concerned public.

5. That Subcommittee for Marine Baselines and Monitoring of the Interagency Committee for Marine Environmental Prediction coordinate marine environmental research, monitoring, and surveillance programs that may have an effect or application to the Ocean Disposal Program. The tasks of the subcommittee would include:
   a. Assessment of present national and regional studies related to ocean disposal.
   b. Determination of additional research requirements.
   c. Allocation of tasks to subcommittee members either individually or jointly, to effectively utilize existing facilities and resources and to avoid duplication of efforts.
   d. Standardization of sampling, analysis and data management methods or development of data conversion techniques for optimum utilization of exchanged information.
   e. Recommendation of policies and practices to ensure that the statutory requirements of PL 92-532 are met by all agencies in a timely manner.

f. Complete responsibility for overall monitoring strategy with particular emphasis on coordination and acquisition of marine data including the consolidation of that data from the National Pollutant Discharge Elimination System that can be used in obtaining total waste loading of the oceanic disposal zones.

g. Establishment of an effective information system. This is an immediate need and should receive high priority consideration. The purpose of the system would be:

   1. To provide effective communication between all participants.
   2. To act as a central clearing house for ocean disposal information.
   3. To maintain effective permit control and insure equity in regulation.
   4. To provide management information and to prepare reports.

An information system such as the one described in the following section is recommended. In view of the problems that have been encountered in the organization and operation of large scale systems such as STORET, ENDEX and NAWDEX, it is recommended that the ocean disposal information system be initially established on

a timeshare system under the direct control of the Ocean Disposal Program.

These recommendations, plus the basic recommendation of supporting research and research planning, involve a high degree of inter-agency cooperation.

Development of a coherent organizational plan logically precedes the development of final criteria and other operational requirements such as permit, surveillance, monitoring and enforcement systems.

Section 2

OCEAN DISPOSAL INFORMATION SYSTEM

2.1 INTRODUCTION

The establishment of an Ocean Disposal Information System (ODIS) is of paramount importance. A well designed ODIS will provide effective communications; control and management; storage and dissemination of data; and generation of reports.

Previous studies conducted to develop a National Coastal Zone Water Quality Monitoring Network, and reviewing progress of the National Pollutant Discharge Elimination System (NPDES) have indicated major problems in incorporating special need programs into centralized computer systems such as STORET, ENDEX, NAWDEX, etc. We recommend initial establishment of a computer system (timeshare) directly under the control of the Ocean Disposal Program.

2.2 IMPLEMENTATION

A consolidation and grouping of several agencies from the six geographical areas surveyed during the ocean disposal study would be the first logical step in a plan. The critical immediate problems would be tackled first. Among the critical problem

areas to be confronted would be the New York Bight. Priorities would be established in advance by a committee of the participating agencies; henceforth called the Ocean Dumping Committee (ODC).

The ODC would evaluate the present information submitted during the IEC ocean dumping field survey. The EPA regional offices involved will be responsible for submitting supplemental information on the disposal sites studied and information on new areas affected by ocean disposal.

This material would be entered into a computer terminal at each regional office. Review and formatting would then be done by the ODP before releasing the material into the information system for general use. Bulk raw data would be mailed to the ODP for batch entry into the existing STORET system.

The next step will require integration of ocean disposal data into the National Coastal Water Quality Monitoring Network, now being developed by the EPA Applied Technology Division.

It should be clearly understood that this implementation is interim, and will require frequent updating and modification until a significant coherent and viable program is realized.

2.3 INFORMATION SYSTEM

The ocean disposal program involves several key federal agencies, regional offices of these agencies, and state level agencies in a complex mix of authority and responsibility. Timely and accurate information is essential to effect smooth operation of the entire ocean disposal program, to maintain equality in regulation and enforcement throughout the nation, and to assure compliance with the goals specified in the Clean Waters Act as amended. Thus, it is recommended that an effective and comprehensive information system be designed and implemented for the entire ocean disposal program. Some basic considerations and recommendations are discussed in the following paragraphs.

2.3.1 Purpose

Information needs of the ocean disposal program vary from basic administrative functions required to process permits to highly complex, detailed reports required for complete management. The main purpose of an information management system is to provide an organized method of acquiring, processing, retrieving, indexing, disseminating and displaying pertinent data, and to do so in a manner which optimally satisfies the needs of the many users of this information.

2.3.2 General Features

Several categories of information are essential to the ocean disposal program. These categories contain data and information pertaining to:

- Permits
- Disposal Sites
- Regulations, Criteria, and Administration
- Enforcement
- Research and Monitoring

2.3.3 Permit Data

Pertinent ocean disposal permit data should be filed and maintained using the National Pollutant Discharge Elimination System (NPDES) presently under development by the EPA. NPDES permit data are stored in the EPA's STORET computer using a software system termed GPSF (General Point Source File). GPSF is a general purpose information storage and retrieval programming "language" which facilitates entry, validation, retrieval, selection and report generation functions.

Permit data is typically a mixture of administrative and technical information pertaining to individual dischargers. The primary sources of this data are the EPA regional offices. Other sources are concerned federal and state regional agencies.

2.3.4 Site Data

Data on individual ocean disposal sites will become quite voluminous and detailed in content, but an anticipated small number of dumping permits to be issued tends to minimize the applicability of an ADP system for storage and retrieval. Thus, a manual or site description catalog is recommended. This catalog would be an expansion of the present Atlas, Report 4460C1545. Major essential catalog elements for each site are:

1. A chart and a detailed description of the site location, its surroundings, history, present use, future plans, and type of materials dumped.
2. A detailed technical description covering physical, chemical, biological, geological, topographical and bathymetrical features.

Sources of these types of information are field studies; scientific literature; marine data banks (such as NOAA's National Oceanographic Data Center), and other similar public and private systems; and research surveys. Users of this data are EPA's national headquarters personnel and the EPA regions.

Thorough reference to source literature should be included in the catalog. The amount and type of data to be included in the catalog would be one of the major decisions during the initial

system design and should be based on an analysis of the prospective user's information needs.

2.3.5 Regulations, Criteria, and Administration

Ocean dumping rules, regulations and criteria are published in the Federal Register, and various administrative procedures exist throughout the regions. The essential need is for an organized, indexed and cross-referenced system for dissemination and storage of information to keep all regions updated on documentation available to assure uniform regulatory procedures throughout the nation.

The primary source of regulatory and criteria data is EPA Headquarters, Washington, D.C. However, provision should be made for "feedback" from the regions to facilitate revisions to existing criteria and successful planning for future programs. Headquarters personnel must have research and monitoring data to support present regulations and criteria.

2.3.6 Enforcement Data

Enforcement data is an important requirement to assure fair and uniform application of the law, and therefore, has a more intense need for rapid dissemination. The system design should include this time-related problem of special handling in the areas of data communication and display.

2.3.7 Research and Monitoring Data

The design of this information system will likely result in the definition of several major sub-categories. Characteristically, this data will be voluminous and extremely varied and detailed in type, format and availability.

It can be anticipated that most of the pure monitoring data will (or can) be made available through various existing automatic data processing systems such as EPA's STORET or NOAA's NOIS systems. In these cases, logistical and procedural routines should be established to provide access to desired data. In most cases, data will not be readily available, and there may be too much manual storage. A candidate solution to this problem would be an indexing system providing "pointers" to data sources, and organized to permit rapid isolation of pertinent sources. This concept is similar to the USGS "NAWDEX" and the NOAA "ENDEX" systems which are automated reference services.

Research data is similarly large in quantity and very broad in scope. Detailed consideration should be given to the essential tools for continuous maintenance of the Bibliography (Report 4460C1542).

Section 3

CRITERIA DEVELOPMENT

3.1 DEFINITION OF CRITERIA

Webster's definition of criteria is--"a standard on which a judgment or decision may be based", and "applies to any definite rule, principle, or measure established by authority".

Development of criteria for the control of ocean disposal has proven to be a highly complex and often subjective job. The history can be traced by scanning the citations of working papers listed in the bibliography of the referenced reports. The fact that interim regulations and criteria were established in less than one year from the enactment of the authorizing laws (October, 1972 - May, 1973) speaks highly of the EPA task force that met this challenge.

3.2 RATIONALE FOR CRITERIA

Implementation of the national ocean dumping policy requires the enactment of laws and executive decrees that are effective in minimizing pollution and are legally enforceable. Adherence to these regulations must be technically, socially, and economically possible. The regulations must be sufficient and necessary, but

Material	Phase	Density	Activity	Persistence	Toxicity	Mode	Vessel	Discharge	Rate
Rock	solid	>2.0	Inert	Permanent	Nil	Bulk	Deck Barge	Overside	Tons/sec
Dredge spoil (sand)	slurry	2.0±	Inert	Permanent	Nil	Bulk	Hopper	Dump	Tons/min
Construction debris	solid	2.0±	Inert	Permanent	Nil	Bulk	Deck Barge	Overside	Tons/sec
Wrecks	solid	>1.0	Inert?	>20 years	Low	Bulk	Tow Barge	Overside	Tons/sec
Conventional munitions	solid	>4.0	Low	Low	Low	Container	Ship	Scuttle	Tons/sec
Radioactives	solid-liquid	>1.0	Low	>20 years	High	Drum	Deck Barge	Overside	Drums/hr
Garbage	slurry	1.0±	BOD	<1 mo.	Nil	Bulk	Dump Scow	Dump	Tons/min
Cannery Wastes	slurry	1.0±	BOD	<1 mo.	Nil	Bulk	Tank Barge	Pump	Gals/sec
Acids/Bases	liquid	1.0+	High	<1 day	High	Bulk	Tank Barge	Pump	Gals/sec
Common salts	slurry	>1.0	Moderate	1 day-1 year	Low	Bulk	Tank Barge	Pump	Gals/sec
Sodium-Calcium	slurry	>1.0	Extreme	<1 hour	High	Bulk	Tank Barge	Pump	Gals/min
Petroleum	liquid	1.0-	Moderate	<1 year	Moderate	Bulk	Tanker	Pump	Gals/hr
Petrochemicals	slurry	>1.0	Low	>1 year	High	Bulk	Tank Barge	Pump	Gals/min
Insecticides, PCB's	liquid	1.0+	Low	>1 year	Extreme	Drum	Deck Barge	Overside	Drums/min
Dredge spoil (mud)	slurry	2.0-	Inert?	Permanent	Nil?	Bulk	Hopper	Dump	Tons/min
Sewage sludge	solid	1.0+	High BOD	<1 mo.	Moderate	Bulk	Dump Scow	Dump	Tons/min
Trash	semi-solid	<1.0	Inert?	1 year	Nil?	Bulk	Dump Scow	Dump	Tons/min

TABLE 3-1 MATERIAL TYPES

IEC INTERSTATE ELECTRONICS CORPORATION

4460C1544

not be capricious nor vague. They may contain quantitative standards and limits which are set arbitrarily, but if the values are scientifically derived, these standards are defensible and constitute justifiable criteria.

With these stipulations as our basic guidelines, the orderly development of criteria requires a body of knowledge regarding ocean waste disposal. The following sub-sections are a distillation of a very large mass of data and provide information on the types of waste materials, dumping methods, disposal sites, compatible combinations, and quantification considerations respectively.

3.3 CLASSIFICATION OF WASTE MATERIALS

Table 3-1 lists material types that are or have been dumped at sea, and includes generalized comparative descriptions of their usual attributes and most common transport and discharge modes. The materials are grouped according to whether they affect the bottom, the water column, or both. The column headings are considered to be the factors which are most influential in determining the fate of a dumped waste and its environmental effect. Solubility is also an important factor but it is determinable only for specific, relatively homogenous wastes, or for discrete elements of a heterogenous mixture. Thus, it cannot be indicated on a listing of general waste types. The phase and

persistence of the bulk materials are partial indicators of solubility. Phase, density and mode are indicators of the horizontal and vertical dispersivity of a dumped waste. Chemical activity, persistence, toxicity, and discharge rate are the prime determinants of effects on the biota of a dump area. Other combinations and comparisons of these factors are applicable for specific areas, depth zones and/or habitats. There are many local exceptions, especially in the type of transport vessel and some materials may be dumped in bulk or in drum at different times. Chemical activity and biological toxicity refer to their immediate or short-term effects and not necessarily to the affects over the period of persistence.

3.4 DISPOSAL METHODS

3.4.1 Vessel Types

The vessel type and method of disposal are major factors in determining the initial dispersion, aesthetics, ultimate fate of some wastes and the relative economic advantages of ocean waste disposal. Representative vessels are illustrated in Figures 3-1 through 3-4. See Table 3-1 for typical material and vessel combinations.

3.4.1.1 Solid Wastes - There are three normal methods used for the disposal of solid wastes: deck barges with over-the-side dumping; dump barges with clam-shell bottoms for disposal; and

hopper barges used in the dredging industry, with valves in the bottom of the barge for dumping.

Deck barges are the most frequently used type of solid waste disposal vehicle, excluding dredge spoil, and for some materials (rock, construction debris, etc.) the most effective means of dumping at sea. This is because the disposal time is long by comparison to other methods, and allows the spreading of materials over a larger area and minimizes buildup in one small area of a dump site. Most dumping is performed by pushing the materials over-the-side with hydraulic jets or a bulldozer. Some barges are available that tip down on one side to allow dumping.

3.4.1.2 Semi-Solid Wastes - Dump barges, as shown in Figure 3-1, are commonly used for the disposal of semi-solid materials, such as sewage sludge, dewatered dredge spoil and other materials with high water content or good flow characteristics. Materials are dumped by the opening of hinged bottom doors. One variation of dump barge has the hinging mechanism at deck level and the entire barge opens like a giant clam shell. This type of barge can dispose of large volumes of material in a short time and is the most economical of the three solid waste barges per unit volume of material.

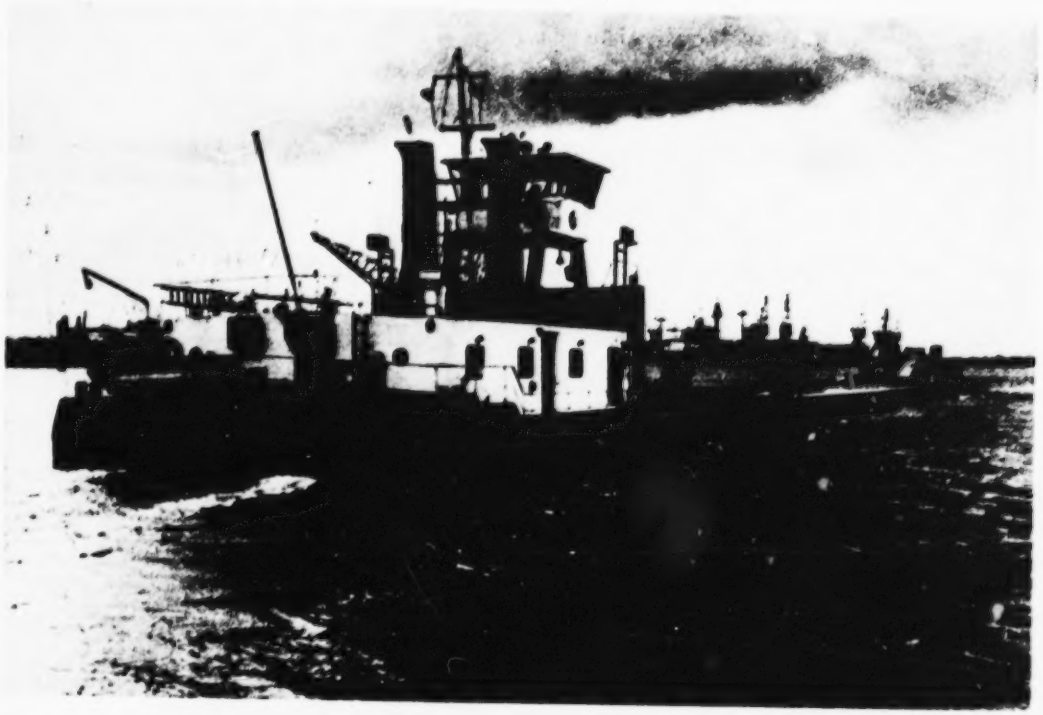

FIGURE 3-1 TYPICAL DUMP BARGE

3.4.1.3 Dredge Spoil - Almost all ocean disposal of dredge spoil is done by hopper dredges. These are ships with built in hoppers which have smaller gates at the bottom than the doors of the dump barges. The U.S. Army Corps of Engineers uses hopper dredges to clear entrance channels through offshore bars by pumping sand into the hoppers through suction pipes. When full, they move to the side or to deeper water to dump. The hoppers are cleaned out by hydraulic jets. A few dredges can pump spoil

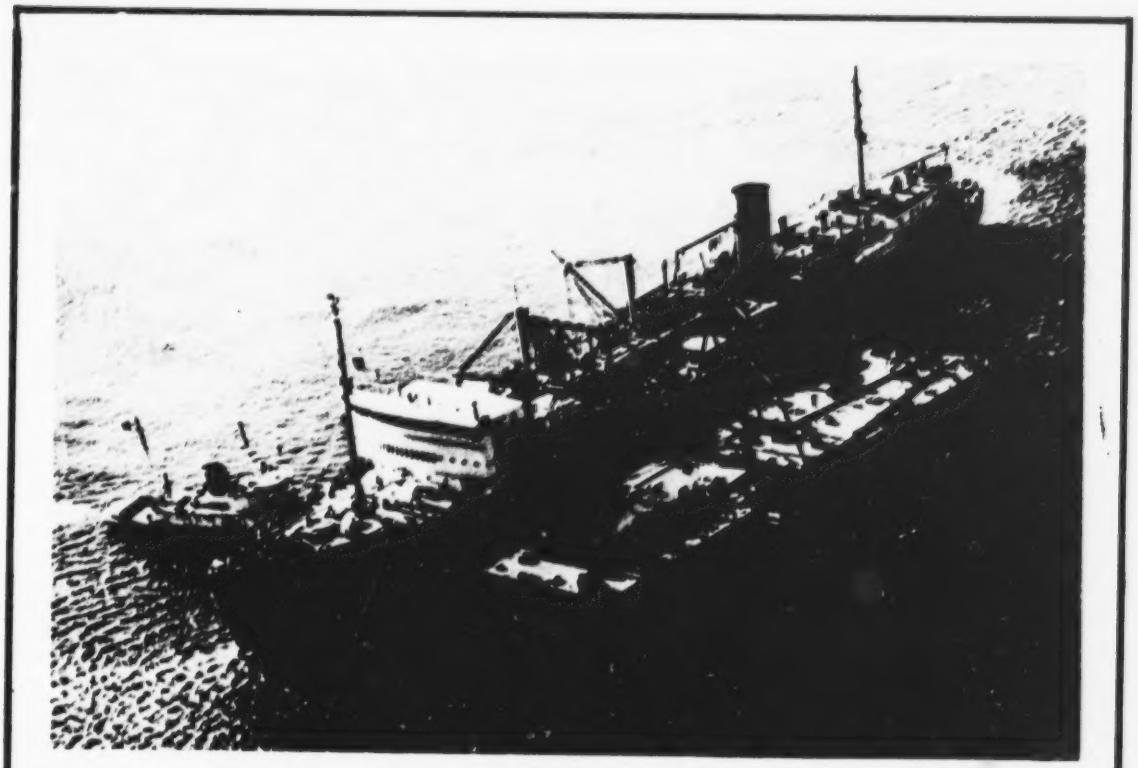

FIGURE 3-2 TYPICAL HOPPER DREDGE

out of the hoppers into a pipeline or a barge brought alongside as shown in Figure 3-2. Others have sidecasters as shown in Figure 3-3. The spoil is pumped from the bottom and discharged out the side without using the hoppers. Figure 3-4 shows a cutaway view of a hopper dredge.

3.4.1.4 Liquid Wastes - There are two methods commonly used for the disposal of liquid wastes: by tanker barges; and by containerization and dumping over-the-side.

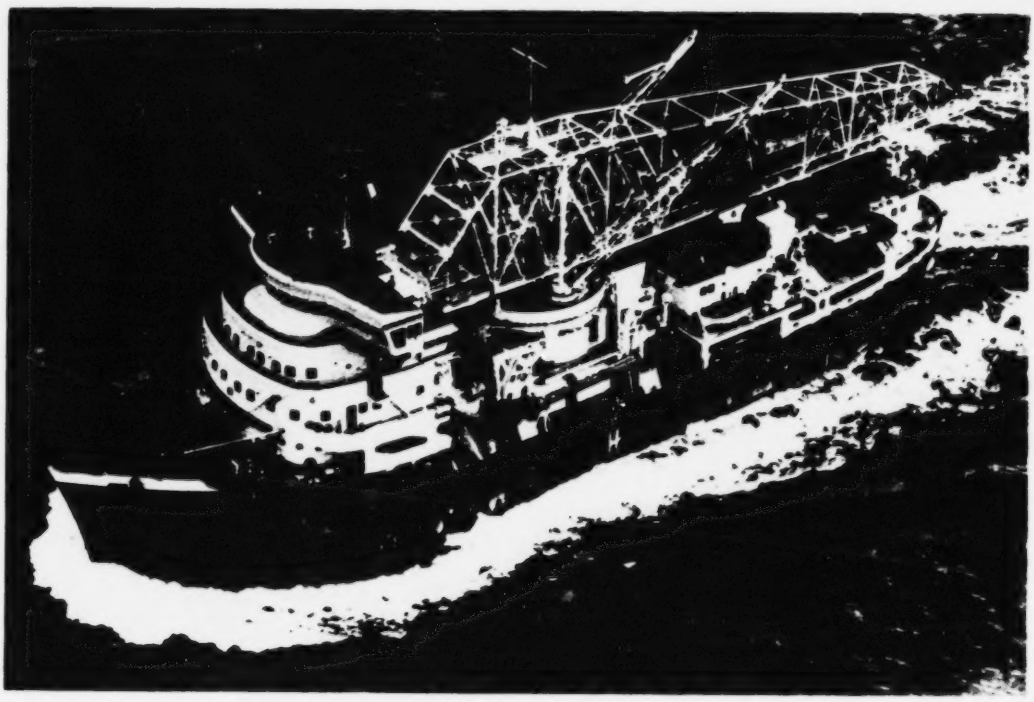

FIGURE 3-3 TYPICAL SIDECASTER

Tanker barges are the most economical method for the disposal of liquid wastes. The removal of several manual steps by pumping results in both smaller crews and fewer vessels required for a given disposal operation. Pumping of the material gives a greater degree of control over disposal rates and by proper plumbing allows dispersion over a large area or into the water column at depth.

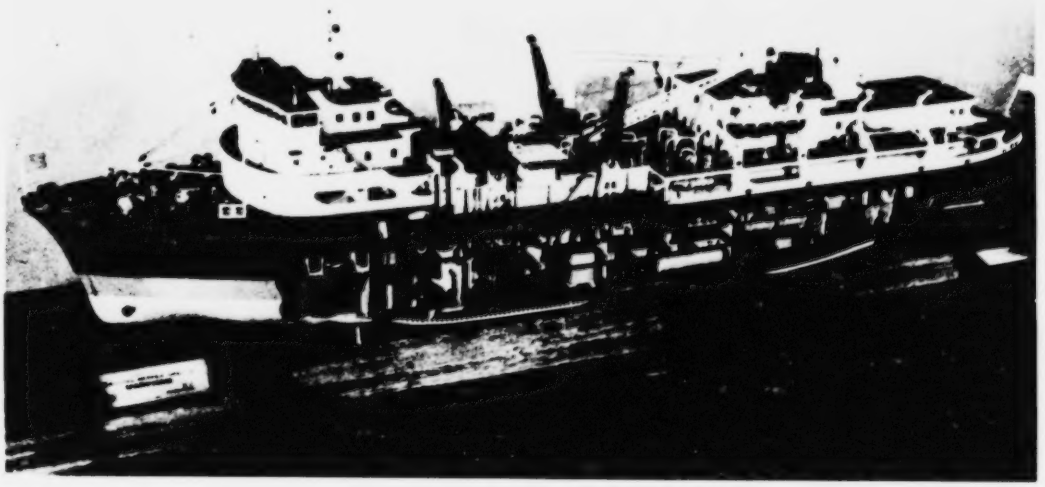

FIGURE 3-4 HOPPER DREDGE CUTAWAY VIEW

3.4.1.5 Miscellaneous - There are variations on each of the methods for disposal of liquid and solid wastes. In one case the disposal of liquid wastes was performed by breaking individual containers and pouring the contents over-the-side. Hulks of decommissioned ships are frequently scuttled as a method of disposal. And in some cases containerization is used for transport of materials to a site with the container being ruptured by hydrostatic pressure while sinking or by physical

methods to promote sinking of the container. Containerization is usually used for the disposal of materials that are immediately toxic to surface fauna or react with water and could cause harm to the personnel dumping the material. Radioactive materials have been disposed of by this method in the past because of their long-term effects and slow degradation. The objective was to contain the materials over their toxic life span.

3.4.2 Discharge Techniques

The preferred method of waste disposal is generally that which allows the greatest control of distribution. This applies to wastes consisting of large discrete objects such as wrecks, hulks, rocks and containers, as well as liquids, slurries, and fine to coarse granular wastes. Dispersal over a large area or through a large volume of water is usually preferred for liquids and some slurries, whereas concentration over a small area or even spreading or spacing is desired for the particulate wastes. In all cases, accurate and reliable navigation or plotting is required. The following paragraphs describe the various material/vessel combinations, control capabilities and preferred distribution schemes.

3.4.2.1 Liquids - For nontoxic and readily miscible liquids or slurries, such as common brines and comminuted cannery wastes, discharge rate control is not critical. They may be dumped from hoppers, tilt tanks or pumped at maximum speed from tanker barges. For fluids which are toxic and degradable, have toxic-like physical effects, or discolor the water; tanker barges with controllable pumps and/or nozzle systems should be employed. Initial discoloration or toxic concentrations may be controlled in the receiving waters on the surface, at depth, or through a given depth range by selection of vessel speed, pumping rate and the number, size and placement pattern of orifices. If aeration is advantageous, liquids may be sprayed downwind through fog nozzles. Pre-discharge dilution may be obtained using venturi suction intakes. Fluids (or solids) which are persistently toxic should not be dumped in the ocean unless they are: containerized in weighted, extended-life vessels; offloaded from deck barges in a spaced pattern that will ensure adequate dilution volume if rupture or leakage occurs; and into an area where natural or artificial deposition of sediments is occurring at a rate that will ensure permanent burial within the lifetime of the containers. Water depth must be adequate to avoid interference with navigation and fishing and the area must not be a benthic breeding, spawning or nursery habitat.

3.4.2.2 Large Objects - Relatively inert and dense material such as wrecks, hulks, rocks, and construction debris rapidly sinks to the bottom with no effect on the water column and very rarely has any prolonged effect upon bottom water quality. The size of the individual pieces usually does not allow use of hopper or dump barges except those with very large doors or those of clamshell construction. Deck barges with a small bulldozer or sweep-arm are the most convenient vessels to use because the waste may be distributed as desired, whereas tilting deck barges can only dump the entire load at one spot. A few benthic animals may be killed during a dump, but the rate of repopulation is sometimes spectacular. This class of waste is frequently used for construction of fishing reefs and the net result is habitat enhancement. The only disposal requirements are adequate water depth for navigation and non-contamination by grease, oil, garbage, or other floating or soluble debris.

Munition filled hulks or containers are a special case. The primary requirement is placement in a deep, out-of-the way area with warnings on the navigation charts. This automatically places them in an essentially barren habitat. Sealing of the hulks or containers is not required because most ordnance is already in heavy metal casings and even the bare explosive chemicals are usually insoluble.

3.4.2.3 Mixed Particulates - Garbage and trash are heterogenous, affecting the entire water column and the bottom. Disposal techniques are either the use of a deck for transport and pushing or washing over the side, or by bottom dump barges. Major problems with this waste are the aesthetic unpleasantness associated with the materials that float, and the nondegrading materials now becoming more evident in the common household waste can. Except for the problem of ingestion of physically harmful materials such as zip-top tabs or plastic bag remnants this waste is not generally considered toxic or harmful. In the study of U.S. coastal areas only one instance of this waste was determined to be disposed of at sea, in small amounts off the coast of Southern California. The present method of disposal is probably acceptable for the volume being disposed, but there is no control over the exclusion of persistent components. Some sorting of materials should be called out in restrictions on this operation. High pressure baling might be used to eliminate any flotsam. The bales could possibly be used in reef construction.

3.4.2.4 Fine Granulates - The hopper barge or dredge is best used for materials that are in a fluid state. Dump scows and deck barges may be needed for materials that do not flow as readily or have been dewatered. For most areas, the preferential ranking of discharge techniques by vessel type would be:

1. Hopper barge (or dredge) - allows the control of discharge rate, extent of area and partial control of depth of release.
2. Dump scow - although dumping is performed in a short time period and not readily varied, it does allow release below the surface of the water.
3. Deck barge - the time honored method, but causes the most surface turbidity and is the least variable and flexible of the common methods.

The finely divided particulate wastes, principally dredge spoil and sewage sludge, affect the bottom and the entire water column. The major problems with disposal of unpolluted dredge spoil are the burial of benthic biota and the temporary increase of turbidity. Vessels used for dredge spoil disposal offer little advancement in reducing turbidity associated with the disposal process. There have been some experiments in the use of sheet plastic barriers and agglutinating chemicals to reduce turbidity, but further research is needed. Burial is unavoidable, however in some areas it may prove more practical to spread spoil in thin

layers over large areas at a rate that allows plants and benthic animals to survive. Only hopper dredges with their speed and gate valves have adequate control to accomplish this discharge technique. Hopper barges would be too slow to cover the area in a reasonable time. Studies have shown that biomass recovery of a buried area occurs in approximately one season and that productivity is even greater afterwards because of the added nutrients. Biotic diversity is reduced by burial and at present the time required to return to a natural community is unknown.

If the wastes are sewage sludge or contaminated dredge spoil, the effects on water quality and benthic habitat are much greater and more persistent. There is need of a trade-off study to determine whether these materials should be handled like degradable toxic liquids, i.e., diluted and dispersed, or if they should be confined to small areas that are simply written off for near term biologic productivity. This decision must be based upon the level and persistence of the toxic effects, the relative economics and habitat value as compared to the cost of alternate disposal methods.

3.5 CLASSIFICATION OF DISPOSAL SITES

At most places around the margins of the continents, beyond the gently sloping continental shelves, the steep continental slopes descend to the oceanic basins. Figure 3-5 shows the commonly

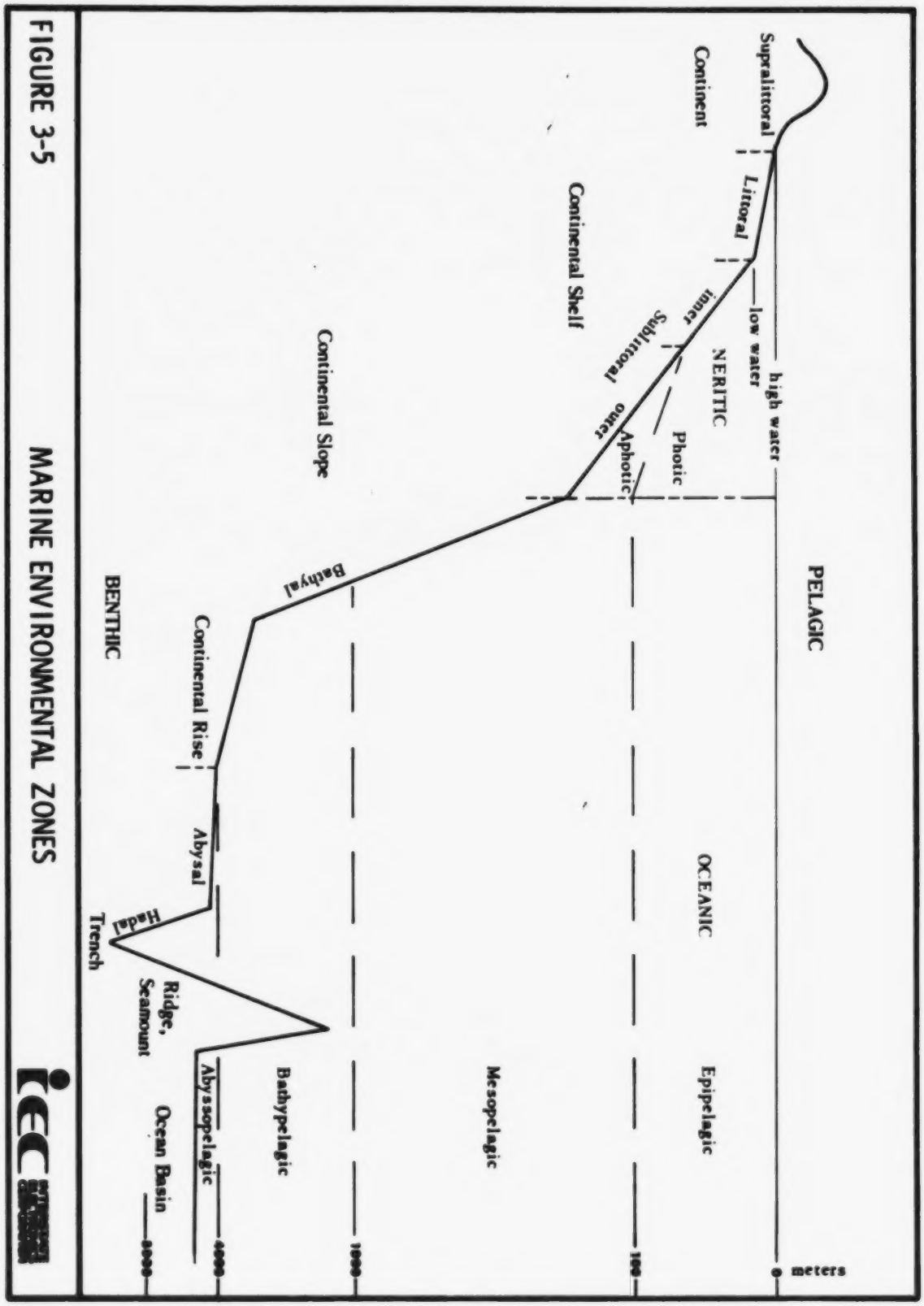

FIGURE 3-5 MARINE ENVIRONMENTAL ZONES

accepted nomenclature for marine environmental zones, both in the water column (pelagic) and on the bottom (benthic). Also shown are the usual relationships of these zones to the major geomorphic divisions.

Table 3-2 is a list of environmental parameters which are deemed important in describing the characteristics of an ocean area in which waste disposal is to be performed. Many of these parameters have been reported using descriptive terms as well as numerical values, and correlative divisions are suggested. Every existing or potential dump site is unique and the values of the parameters listed in Table 3-2 will not only change from one area to another, but many will vary with time, especially seasonally, at the same location. Valid comparisons between the marine environmental zones may be made only within a specific climatic region for a given time of year. Table 3-3 is an example of an interzone comparison chart for a north temperate region (Cape Cod to Cape Hatteras) in October. By examining a quarterly or monthly series of such charts, the following generalizations for this region may be made:

(1) Width, relief and sediment type do not vary seasonally in any benthic zone.

(2) Temperature, salinity, DO, turbidity, and biota are static in the lower bathypelagic, abyssopelagic, bathyal rise, abyssal and hadal benthic zones.

1. Depth (Meters):	a. Shelf 0-200, b. Slope 200-3000, c. Rise 3000-4000, d. Basin 4000-6000, e. Trench >6000.
2. Relief (Degrees):	a. Flat <0.1, b. Shelving - Undulating 0.1 - 0.5, c. Sloping - Incised 0.5 - 2, d. Steep - Irregular 2 - 10, e. Precipitous - Rough >10.
3. Sediment Type:	a. Lithogenous, b. Biogenous, c. Hydrogenous, d. Meteoritic
4. Sediment Size ($\phi = -\log_2 mm.$):	a. Clay >8, b. Silt 8 to 4, c. Sand 4 to -1, d. Granules -1 to -2, e. Pebbles -2 to -6, f. Cobbles -6 to -8, g. Boulders >-8.
5. Sediment Sorting ($\phi = \frac{1}{2} (\phi\ 84 - \phi\ 16)$):	a. Well Sorted <1, b. Moderately Sorted 1 - 2, c. Poorly Sorted >2.
6. Sediment Thickness (Meters):	a. Bare 0, b. Veneer 0-1, c. Thin 1-10, d. Medium 10-100, e. Thick >100.
7. Sedimentation Rate (cm./yr.):	a. Very Slow 0 -0.1, b. Slow 0.1 - 1, c. Moderate 1-10, d. Fast 10-100, e. Very Fast >100.
8. Sediment COD (mg/L):	a. Low <250, b. Moderate 250-500, c. High 500-750, d. Very High >750.
9. Sediment Eh (Volts):	a. Oxidizing +0.4 to 0.0, b. Neutral 0.0 to -0.2, c. Reducing >-0.2.
10. Average Annual Precipitation (Inches):	a. Arid 0-20, b. Light 20-40, c. Moderate 40-60, d. Heavy >60.
11. Average Daily Solar Radiation (Langleys = gm-cal./cm^2):	a. Very Low <100, b. Low 100-200, c. Moderately Low 200-300, d. Moderately High 300-400, e. High 400-500, f. Very High >500.

TABLE 3-2 DESCRIPTIVE AND NUMERICAL DIVISIONS OF ENVIRONMENTAL PARAMETERS

IEC INTERSTATE ELECTRONICS CORPORATION

12.	Operational Wind Speed (Knots):	a. Calm <1, b. Light Air 1-3, c. Light Breeze 4-6, d. Gentle Breeze 7-10, e. Moderate Breeze 11-16, f. Fresh Breeze 17-21, g. Strong Breeze 22-27.
13.	Wind Direction:	a. Onshore, b. Offshore, c. Up Coast (Northward), d. Down Coast.
14.	Surface Turbidity (JTU):	a. Very Low 0-10, b. Low 10-20, c. Moderate 20-30, d. High 30-40, e. Very High >40.
15.	Bottom Turbidity (JTU):	Same.
16.	Net Surface Current Speed (Knots):	a. None, b. Slow <0.2, c. Moderate 0.2-1.0, d. Fast >1.0.
17.	Net Surface Current Direction:	a. Onshore, b. Offshore, c. Up Coast, d. Down Coast.
18.	Net Bottom Current Speed (Knots):	a. None, b. Slow <0.2, c. Moderate 0.2-1.0, d. Fast >1.0.
19.	Net Bottom Current Direction:	a. Onshore, b. Offshore, c. Up Coast, d. Down Coast.
20.	Net Vertical Current Speed (Knots):	a. None, b. Slow <0.2, c. Moderate 0.2-1.0, d. Fast >1.0.
21.	Net Vertical Current Direction:	a. Upwelling, b. Downwelling.
22.	Tidal Current Speed (Knots):	a. None, b. Slow <0.5, c. Moderate 0.5-3.0, d. Fast >3.0.
23.	Tidal Current Orbital Eccentricity (Asix L/Axis S):	a. Rotary <2, b. Elliptical 2-10, c. Linear >10.
24.	Surface Water Temperature (^{o}C.):	a. Cold -2 to 5, b. Cool 5-15, c. Warm 15-25, d. Hot >25.
25.	Bottom Water Temperature (^{o}C.):	Same

TABLE 3-2(Cont.)

DESCRIPTIVE AND NUMERICAL DIVISIONS OF ENVIRONMENTAL PARAMETERS

26. Surface Salinity (^{o}/oo = ppt = g/Kg.):	a. Brackish <30, b. Hyposaline 30-34, c. Normal 34-36, d. Hypersaline 36-40, e. Brine >40.
27. Bottom Salinity (^{o}/oo):	Same
28. Surface Water Density (g/cm^3):	a. Very Light 1.00-1.02, b. Light 1.02-1.03, c. Moderately Light 1.03-1.04, d. Moderate 1.04-1.05, e. Moderately Dense 1.05-1.06, f. Dense 1.06-1.07, g. Very Dense >1.07.
29. Bottom Water Density (g/cm^3):	Same
30. Surface pH:	a. Acid <6.0, b. Slightly Acid 6.0-6.5, c. Neutral 6.5-7.5, d. Slightly Alkaline 7.5-8.0, e. Normally Alkaline 8.0-8.5, f. Very Alkaline 8.5-9.0, g. Extremely Alkaline >9.0.
31. Bottom pH:	Same
32. Surface Dissolved Exygen (DO, ml/L):	a. Extremely Low <2.0, b. Very Low 2-4, c. Low 4-6, d. Moderate 6-7, e. High 7-9, f. Very High 9-11, g. Extremely High >11.0.
33. Bottom DO (ml/L):	a. Extremely Low <1.0, b. Very Low 1-3, c. Low 3-4, d. Moderate 4-5, e. High 5-6, f. Very High 6-8, g. Extremely High >8.0.
34. Pelagic Biomass (g/m^3):	a. Barren <0.01, b. Very Low .01-.1, c. Low .1-1, d. Moderate 1-10, e. High 10-100, f. Very High >100.
35. Benthic Biomass (g/m^2):	a. Barren <0.1, b. Very Low .1-1, c. Low 1-10, d. Moderate 10-100, e. High 100-1000, f. Very High >1000.
36. Pelagic Diversity (No. of Species):	a. Monospecific 1, b. Restricted 2-10, c. Varied 10-100, d. Diverse 100-500, e. Highly Diverse >500.
37. Benthic Diversity (No. of Species):	Same

TABLE 3-2(Cont.) DESCRIPTIVE AND NUMERICAL DIVISIONS OF ENVIRONMENTAL PARAMETERS

IEC INTERSTATE ELECTRONICS CORPORATION

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Mid-Atlantic Coast Profile - October

Zone	Width (n. mi)	Relief (°)	Currents (Knots)	Temp. (°C.)	Salinity (°/oo)	DO (M^3/l)	Biomass (G/M^3)	Sediment Type
Photic Neritic	30		0.2	18°	32	5	1.0	
Aphotic Neritic	25		0.1	13°	35	3	.3	
Epipelagic	--		0.1	16°	34	6	.5	
Mesopelagic	--		0.1	8°	35	4	<.2	
Bathypelagic	--		0.2	4°	35	3	--	
Abyssopelagic	--		0.1	2°		2	--	
Littoral	0.1	0.9					4	sand
Inner Sublittoral	30	0.07		18°			6	sand
Outer Sublittoral	25	0.2		13°			10	silt
Bathyal Slope	40	0.8		8°			2	silt
Bathyal Rise	80	0.2		4°			-	clay
Abyssal	--			2°			-	clay

TABLE 3-3 INTERZONE COMPARISON CHART

(3) Bathypelagic waters are cooler and less saline than shallower waters.

(4) Minor seasonal variations occur in the mesopelagic and bathyal slope zones. Water is warmest and saltiest in winter.

(5) Greater seasonal variations occur in the neritic and epipelagic zones. Water is warmest in summer, but still saltiest in winter.

(6) A thin layer of fresher water usually overlies the saline waters of the neritic zone near river mouths.

(7) Neritic waters are freshest and most turbid shortly after the maximum stream runoff period (late spring).

(8) Benthic biota is most varied in the littoral zone, most abundant in the silty, outer sublittoral zone, and both diversity and biomass decrease sharply seaward.

(9) Pelagic biota is most varied and abundant in the neritic zone with a rapid decrease in the oceanic zones where it is almost restricted to the epipelagic and near-bottom waters. Seasonal maximum is in the spring.

(10) Dissolved oxygen decreases with depth and towards land. Seasonal maximum is in the spring.

(11) Except for temporary, wind-driven surface currents up to two knots and the rotary tidal current of 0.5 knots, permanent currents average about 0.1 knots through all zones. Neritic currents flow seaward (SE) on the

surface and toward estuaries near bottom. Oceanic currents trend SSW, representing the western side of a large eddy from the Gulf Stream. Velocities of 0.2 knots are common in the bathypelagic zone (Counter-Current).

3.6 MATERIAL/METHOD/SITE COMPATIBILITY

Present ocean disposal is of three general types. Inert or nontoxic materials are dumped at shallow, near-shore sites, conveniently located near the waste source, to reduce hauling costs. Dangerous or toxic materials are dumped in deeper water at larger, offshore sites. An intermediate class consists of garbage, cannery wastes, and sewage sludge which have an oxygen demand but are at least partially degradable. Much dredge spoil, especially from industrial ports, also has a high BOD and like most sewage sludge, has an appreciable quantity of heavy metals and other persistent toxic material. This intermediate class of material has been dumped in both shallow and deep water, mostly dependent upon the required hauling distance. On the Gulf and East coasts, sludge and contaminated spoil have been dumped in relatively shallow water (less than 30 meters). Off California, garbage has been dumped in water over 800 meters deep, but this site was located only six miles offshore.

Depth and/or distance from shore is a good basis for determining whether a particular site is suitable for the disposal of a given waste. Nearly all other location factors, socio-economic as well as environmental, are determined by the depth/distance factor. Assuming that ocean disposal has the lowest priority in competitive usage of a marine area, Table 3-4 is a matrix which combines the material types of Table 3-1 with the environmental zones of Table 3-3 and gives a compatibility rating of good (A), fair (B), or poor (C) for the acceptable combinations. Ungraded combinations are considered unacceptable because of either exclusive competing uses or needless hauling distance. It must be further assumed that the available area and/or water volume is large enough to assimilate the amounts of wastes to be disposed and that preferred operational practices are employed for each material type, as given in Section 3.4.2.

3.7 QUANTIFICATION CONSIDERATIONS

Based upon the information presented in the foregoing subsections, it would seem to be a simple task to develop criteria stipulating which wastes may not be dumped into the ocean at all and where and how to dump those wastes that are acceptable. Almost everyone with a nominal background of science and technology would intuitively arrive at conclusions similar to those presented in Table 3-4. Controversy does not occur until one begins to apply numerical answers to such questions as: What

Material	Photic Neritic	Aphotic Neritic	Epi-pelagic	Meso-pelagic	Bathy-pelagic	Abysso-pelagic	Littoral	Sub-littoral	Sub-littoral	Bathyal	Abyssal
Rock							*	*	A		
Dredge spoil-sand							*	A	B		
Construction debris								*	A		
Wrecks								*	A		
Conventional munitions					C	B				C	B
Radioactives											
Halogenated organics											
Dredge spoil-mud	C	B	A	A				C	B	A	
Dredge spoil-toxic			C	C	B	B				C	B
Sewage sludge											
Sodium-Calcium			C	C	C	B				C	B
Organic chemicals					C	B				C	B
Trash			C	C	B	B				C	B
Acids/Bases			C	B	B	B					
Common salts			C	B	B	A				B	
Petroleum			C								
Garbage		C	A	A					C	A	
Cannery wastes		C	A	A					C	A	

TABLE 3-4 MATRIX OF COMPATIBILITY

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is the dividing line, in years (months?) between "degradable" and "persistent"? When does turbidity, in Jackson Turbidity Units, become aesthetically offensive? What color should water be? What concentration of "X" is acceptable? What volume should be allowed for a mixing zone (where higher concentrations of "X" are accepted)? Some of these subjective values can be partially obtained by objective methods. For example, bioassays can determine mortality rate for a given organism at various concentrations of "X". This only compounds the question to: Is the death of 10% (5%, 1%, a single individual) unacceptable and was the best organism selected for the test?

A two-stage approach to obtaining these answers was recommended. The first stage was obtaining a concensus of opinion from a statistically significant number of those who are familiar with the problems and requirements of ocean disposal operations and marine ecology. The Ocean Disposal Program held workshop conferences to obtain a concensus for drafting the interim criteria. The field surveys by interviewers expanded both the numbers of opinions and the range of viewpoints and interests. Most of this later data was incorporated into the final draft of the interim criteria, as published in the Federal Register of May 16, 1973.

The second stage is now underway. It is basically a trial and error method that is scientifically guided and systematically controlled. Several substages are recommended:

1. Waste load inventory - determination of the pollutant input load to ocean regions from all sources; ocean dumping, outfalls, rivers and streams, vessel operations and from other ocean regions.
2. Baseline study - determination of the present environmental status at disposal sites and the surrounding area.
3. Monitoring study - determination of the environmental changes resulting from the application of the criteria and subsequent amendments.
4. Optimizing program - the above three sources of data will determine what "errors" occur from "trial" criteria. The goal is to obtain improvement of the environment with a minimum of regulatory control. The law of diminishing returns will apply as improvement occurs and something short of perfection must ultimately be accepted as a future status quo.

Thus, the interim criteria are only one step in an evolutionary process in which the subjectively derived numerical values are periodically adjusted. These adjustments will probably be

stricter in some areas or for some materials, but more relaxed in others. The initial interval between adjustments should be yearly, which is the minimum period to ascertain seasonal environmental variations. With good organization and communication between regulatory agencies, the dumpers and an aware public, there should be no confusion as to what regulations are in effect at any time.

Section 4

OCEAN DISPOSAL MONITORING

4.1 INTRODUCTION

To maintain control over the quality of a disposal site and adjacent area and to provide insight into the potential problems associated with dumping in a specific area, an efficient monitoring program is an essential part of a comprehensive disposal program.

4.2 INFORMATION NEEDS

There is a need for information of sufficient accuracy and depth to allow rational decisions to be made concerning the use of specific disposal sites. This information can be categorized into three broad areas:

- Information to determine the ecological baseline and probable impact of specific wastes on the environment of a specific site.
- Crisis information to permit steps to be taken to prevent non-reversible damage to site ecology (or area ecology) by a single waste or a combination of wastes.
- Trend information to prevent subtle alterations from long term use of a disposal site.

The information must provide for comprehensive evaluation of a site on both economic and biotic terms in enough detail so as to define any detrimental effects to not only the site itself, but also to areas outside of the site, and sometimes long distances away.

Three basic types of information must be utilized for purposes of evaluating a disposal site, they are:

- Existing information that has been collected and archived in numerous data banks.
- Baseline study data collected for the express purpose of site evaluation before dumping begins.
- Surveillance monitoring data collected for purposes of validating decision processes or for studying presently active sites.

A considerable volume of information has been written on most areas of the coastal United States. Unfortunately, much of it is not readily obtainable or in a format that is usable. In many areas the data is sparse in both areal and synoptic coverage. Availability varies from computerized files to material on the shelves of university laboratories, or in private collections. A program should be instituted to collect, screen, and analyze data under constraints necessary for site evaluation. In some cases it is the only baseline data available.

New baseline information must be collected. In the case of active sites, it must be adequate enough to permit an analytical comparison between present site conditions and historical conditions.

Data collected for surveillance will be used for assessing the effects of dumping operations under existing standards and to provide information for periodic re-evaluation of the regulations. It is necessary to maintain control over the use of disposal areas through continuous monitoring of the sites. It is important to maintain a flexible approach in establishing data requirements and demand only that data which will provide useful information for site management. Burdening a dumper with excess data requirements will not lead to candor in communications and the interaction that is necessary for a smooth flowing program.

4.3 SURVEY STRUCTURES

Initial effort in any information collection plan must be directed toward determining those parameters that are necessary to meet the program requirements. This planning should stress collecting information in as timely and economical a method as possible. The steps in this collection process are:

- Outline data requirements for the planned use of the site.

- Locate existing sources of information that fit the data requirements.
- Determine the information requirements not met by existing information.
- Outline all possible sources of "new" data and establish a program for collecting the data.
- Again determine that information not available from the above sources.
- Collect information from all sources.

By far the most important portion of this process is the outlining of data requirements. This is a site-by-site analysis of what information is necessary for the intended use of each site. Some generalization is possible where similar sites or uses are within similar regional oceanic areas. But in most the intended use will set the information requirements. Generalization can lead to the collection of unnecessary volumes of information that will only slow the analysis process. Careful attention to detailing parameters and frequencies of data collection will provide the information in sufficient volume to correctly analyze the site quality and predict trends but will not overwhelm the analyst with unnecessary duplication or excess data.

Literature searches for studies, cataloging of data on computerized systems, letters to educational institutions and consultants in the local area of a site, in some cases, will provide a valuable base of information. This information will be in various forms with varying ease of availability. Computerized information will provide the most readily available and easily formatted data and can be manipulated to provide the type of report, summary, averages, and even graphic plots that are best used in the analysis of an area. It may not be in sufficient detail for a specific site, but it can provide an initial look at the health of an area near the site. The most detailed information is usually in the form of scientific publications, which are difficult to reformat for a specific use.

After a redetermination of what data is still needed, a study of institutions that are active in the ocean area of the dump site who have existing programs that could provide information to further fill the gaps in data, should be initiated. Those with programs that are near a site may be willing to collect data at the site with minor alterations in the program. It may require some funding in order to collect the type of information necessary. Private firms may also be involved in data collection that by proper interface could provide useful information.

The remaining unavailable information must then be contracted to study groups or the dumping applicant(s) must be required to furnish the information. In some cases the latter will be sufficient, but in cases where multiple applicants are involved an outside firm should be contracted to obtain the information.

The initiation of any new data collection must be planned to obtain the required information in as quick and economical a manner as is possible. Data should include a representative of the worst conditions for waste disposal as possible (i.e., in summer months when surface temperature is at a maximum and surface mixing due to wind driven currents are at a minimum) and should be collected on a seasonal basis.

4.4 INFORMATION CATEGORIES

In order to set out those parameters that are important to a particular type of material or dumping operation, several categories of information about the dumping operation must be obtained:

- The materials to be dumped must be known in as detailed a manner as possible.
- The method of transport of the waste.
- The method of waste dumping.
- Volumes of waste dumped per load.
- Number of loads per unit time.

- The variability of loads in concentration or mix of materials.

The material(s) to be disposed of must be known in detail so that a minor part does not escape into an area that could concentrate beyond allowable limits or combine with a second waste to become toxic to fish life. A company may be disposing chemicals that vary in concentration or mix from load to load and this variation must be known to properly assess the operation.

Methods and equipment used in disposal operations are another primary factor in assessment. Vessel type, cruising speed, size, draft, load capacity, disposal rate, dilution rate, and unloading speed are some necessary parameters.

Usage of a site is another important parameter that must be determined. Therefore, short term use as well as long term use must be known. A dumper should be allowed to dump only a predetermined amount of waste over a fixed length of time.

4.5 MONITORING DISPOSAL SITES

Section 102 of Public Law 92-532 charges the administrator of the Environmental Protection Agency with establishing criteria for reviewing and evaluating ocean disposal permit applications. The criteria was based on, but not limited to, nine basic guidelines.

Of these, five require an effective monitoring program under the cognizance of EPA and responsive to the EPA to meet the intent of the law. They are:

(a) The effect of such dumping on human health and welfare, including economic, esthetic and recreational values.

(b) The effect of such dumping on fishing resources, plankton, fish, shellfish, wildlife, shorelines and beaches.

(c) The effect of such dumping on marine eco-systems, particularly with respect to:

1. The transfer, concentration and dispersion of material and its by-products through biological, physical, and chemical processes.
2. Potential changes in marine eco-system diversity, productivity, and stability.
3. Species and community population dynamics.

(d) The persistence and permanence of the effects of the dumping.

(e) Dumping of particular volumes and concentrations of such materials.

To meet these guidelines, the EPA will require access to information on the marine eco-system in quantity, quality and diversity. An entirely new approach must be made to marine

monitoring. Title II of the referenced law authorizes the National Oceanic and Atmospheric Administration to establish a continuing program of monitoring and research regarding the effects of dumping of materials into ocean waters or other coastal waters where the tide ebbs and flows or to the Great Lakes or the connecting waters. Unfortunately, the law did not establish effective laison machinery for insuring cooperation between the Environmental Protection Agency, the U.S. Army Corps of Engineers, and the U.S. Coast Guard. An extremely high level of cooperation, along with interagency funding commitments will be necessary to establish a realistic monitoring program. Further compounding the situation is a lack of baseline data on existing disposal sites. The need is to design a monitoring program that is capable of expanding to at least a decade. Cost estimates for such a program will initially seem exorbitant, but will undoubtedly be minor when compared to the costs of possible permanent damage to the marine ecosystem upon which we are so highly dependent in our food chain.

It must be stressed that in many cases the term "sampling" or random gathering of data is confused with monitoring. Monitoring is defined here as an established routine program whereby information on specific selected parameters is collected and evaluated at regular intervals.

4.6 INITIAL DATA ACQUISITION

It is recommended that consolidation be made of most ocean disposal sites for all materials other than polluted dredge spoil. Consolidation of neighboring sites will reduce the magnitude of the problem of determining initial data bases for active sites. Due to wide variation of the geographic conditions and their impact upon a physical, chemical and biological definition of the disposal sites, separate data acquisition plans will have to be formulated for each region. As part of the acquisition plan, specific bioassay programs must be developed. Bioassay is defined as an experiment using aquatic organisms or their individual organs to examine the response (usually detrimental, but not necessarily so) to substances or energy added to or subtracted from the water. Also considered to be bioassays are those experiments where organisms are fed or injected with a substance. Although bioassay presently appears to be unsuitable itself for the establishment of the impact of waste on the marine environment, it is considered that bioassay will provide vital information for such purposes once developed to a standardized level. This development procedure should be incorporated with the initial data acquisition program. In addition to the physical and chemical analysis of the site, the program must include studies of pollution transport methods, including pollution of the dump site from the atmosphere and from material flowing from riverine sources. This requires

coordination with the EPA National Pollutant Discharge Elimination System, (point source discharge permit program), the U.S. Army Corps of Engineers Waterways Experiment Station, and the various state and local agencies that are concerned with disposal of material via rivers, creeks and streams.

The first major step--is the specification of parameters to be measured in the marine pollution monitoring system. Again, this operation will require interagency and international cooperation on a level that has seldom been achieved in the past.

4.7 DISPOSAL OPERATION CONTROL

Requirements for improved sampling to collect both research and regulatory data have been emphasized at various points in this report. These requirements and the research and development programs needed to fulfill them are discussed in the following sub-sections.

4.7.1 Surveillance Monitoring

Monitoring and control of offshore disposal may be accomplished through the use of an automatic, tamper proof vessel log similar in concept to those used by the airlines and trucking firms. A Disposal Operation Control System is required to provide the responsible agency with the following recorded information:

- Position of vessel at time of dump.

- Time and date of dump.
- Name of vessel.
- Name of captain or owner.
- Type of waste material, and
- Source of material.

The system should also provide the ships captain with local and long distance navigation data and site arrival information.

There should be no operational restrictions invoked by the control and monitoring system. It should be an all weather system capable of around-the-clock operation. The design should be flexible enough to permit use at all approved disposal sites. It should have the capability for monitoring all ocean dumping vessels; both self-propelled and towed. If possible, the system should be portable for use on a vessel with a minimum of preparation. If no exchange of signals between the towed vessel and tug is necessary, the dumping information may be telemetered to the responsible agency at the time of dump (real time) or through recorded data (post occurrence) supplied to the agency upon return of the vessel to port. The latter being a deterrent rather than direct control. A captain dumping in an unauthorized area, would be immediately identified by the control agency. Stiff penalties on operators dumping in unauthorized areas would then be imposed.

4.7.2 Research Monitoring

In order that a control system be fully effective, an environmental monitoring program must be established to provide support. Current programs for monitoring the environmental effects of wastes on marine ecosystems are inadequate. Also, present dumping techniques rarely take into account ocean current structure, which can result in the deposit of dump material many miles from the designated dump site. Lack of knowledge of mass transport makes it difficult, if not impossible, to determine the actual receiving site for past disposal operations and establishing locations for chemical and biological surveys. Techniques must be developed which will establish the final resting point of the waste deposits and permit implementation of a regular monitoring program to establish the physical, chemical, and biological profiles of each dump site.

4.7.3 General Requirements and System Approach

It is recommended that a program be established to design a system and develop a comprehensive implementation plan for disposal operational control and monitoring. The system plan must consider all areas from permit issue through final reporting of each disposal operation.

The system approach must consider equipment that will:

- Accurately mark the dump site.

- Sense the location of dump.
- Sense the occurrence of dump.
- Sense the physical environment at the dump site.
- Record all data, and
- Automatically process the data and flag any improper activity.

Both real time and post-occurrence reporting of the data should be considered. The following system features are considered desirable:

- Positive detection of dumping violations.
- Simple operating procedures.
- Minimal equipment.
- Reliable proven equipment.
- All weather equipment.
- Common equipment for different types of vessels.
- Common equipment for all parts of the country.
- Capable of expansion to meet future disposal requirements.
- Designed for maintenance by semi-skilled field personnel.
- Operational efficiency.
- Tamper proof.
- Cost effective.

4.7.4 Candidate Systems

A large number of candidate sub systems may be considered. Of these candidates, the following is a list of those most attractive:

A. Disposal site marking

Acoustic bench mark

Acoustic transponder

Lighted surface buoy and radar reflector

B. To sense physical environmental conditions, insitu

Current speed and direction sensors

Temperature sensors

Salinity sensors

C. To sense occurrence of dump

Vessel draft sensors

Monitor dump commands and actuators

Monitor dump valves, doors, etc.

Manual event entry by ship's officer at start and end of each dump

D. To sense location of vessel upon arrival at disposal site

Loran A

Loran C

Omega

Decca

Radio direction finder (shipboard)

Radar (including vessel traffic radar system)

Satellite

Raydist

VLF Area navigation

E. To record the data

All sensor data transmitted to ship acoustically. All sensor data transmitted to shore via radio or hardwire

Magnetic tape

Radio transmission to shore

Punched paper tape

Teleprinter

Direct alpha-numeric printout

A system testing and evaluation procedure must be established covering performance, reliability, maintainability, operation and costs. The various candidate systems must be submitted to the evaluation procedure and a recommended or "preferred" system selected.

An example of an ideal disposal control and monitoring system is described below:

The basic system uses Loran for navigation and position fixing, an events unit for entering start and end of dump and other significant events and a magnetic tape to provide a permanent record of the data. This basic system could be augmented by positive dump sensing when appropriate. An acoustic beacon would be installed at each dump site (using high accuracy navigation techniques for placement) for positive identification. Also, an instrument string containing current meters, temperature sensors, and salinity sensors would be attached to the beacon and the environmental data transmitted to the ship acoustically and recorded. The current speed and direction data would be displayed to the captain to aid in positioning the ship. In operation, ship position is continuously recorded (every six minutes) by recording two lines of position (LOP) from two on-board automatic-tracking Loran receivers. Also, the two LOP's may be displayed to the captain to use at his discretion as a navigation aid. The captain presses a button on the events unit at the start of dump and another button to indicate the completion of dump.

The equipment for the basic system can be housed in a single equipment rack which can be table or desk mounted, requiring very little shipboard space. Only six electrical connections to the rack would be required; two for primary

electrical power, two for the acoustic transducer, and two for RF (one antenna and one ground). It may be possible to use the ship's existing fathometer for the acoustic transducer.

The simple installation and low weight packaging is a decided advantage since it permits use of a "portability" concept for use aboard ships that only occasionally dump and do not justify the investment of a permanently installed system. The basic system includes no equipment for sensing the occurrence of dump, relying upon the captain to enter the start of dump and end of dump via the events unit. Certain situations require a more positive dump detection scheme. To accommodate these applications, a draft sensing sub-system could be added.

The problem of monitoring disposal operations could be solved in a practical way by employing a system similar to the one described. The system satisfies all requirements while representing low cost approaches which are immediately applicable for the present dump sites and require no modification should the dump sites move offshore 150-200 miles. Furthermore, the basic system can be used in any area of the United States, except Southern California, which has only one Loran line of position.

4.8 DISPOSAL OPERATION MONITORING USING SATELLITE TECHNIQUES

In 1972, the National Aeronautical and Space Administration launched the first of a series of experimental satellites, the Earth Resources Technology Satellite (ERTS). This program is a major effort in the application of remote sensing technologies for practical and efficient management of earth resources. The sensor system installed in ERTS A incorporates a four-channel multi-spectral scanner system. It has provided some rather spectacular results that can be applied to the monitoring of waste disposal operations from point source and non point source origins in lakes, rivers and oceans.

Figure 4-1 illustrates the overall ERTS system. Systematic repeating ERTS coverage under nearly constant observation conditions has been obtained. The ERTS observatory operates in a

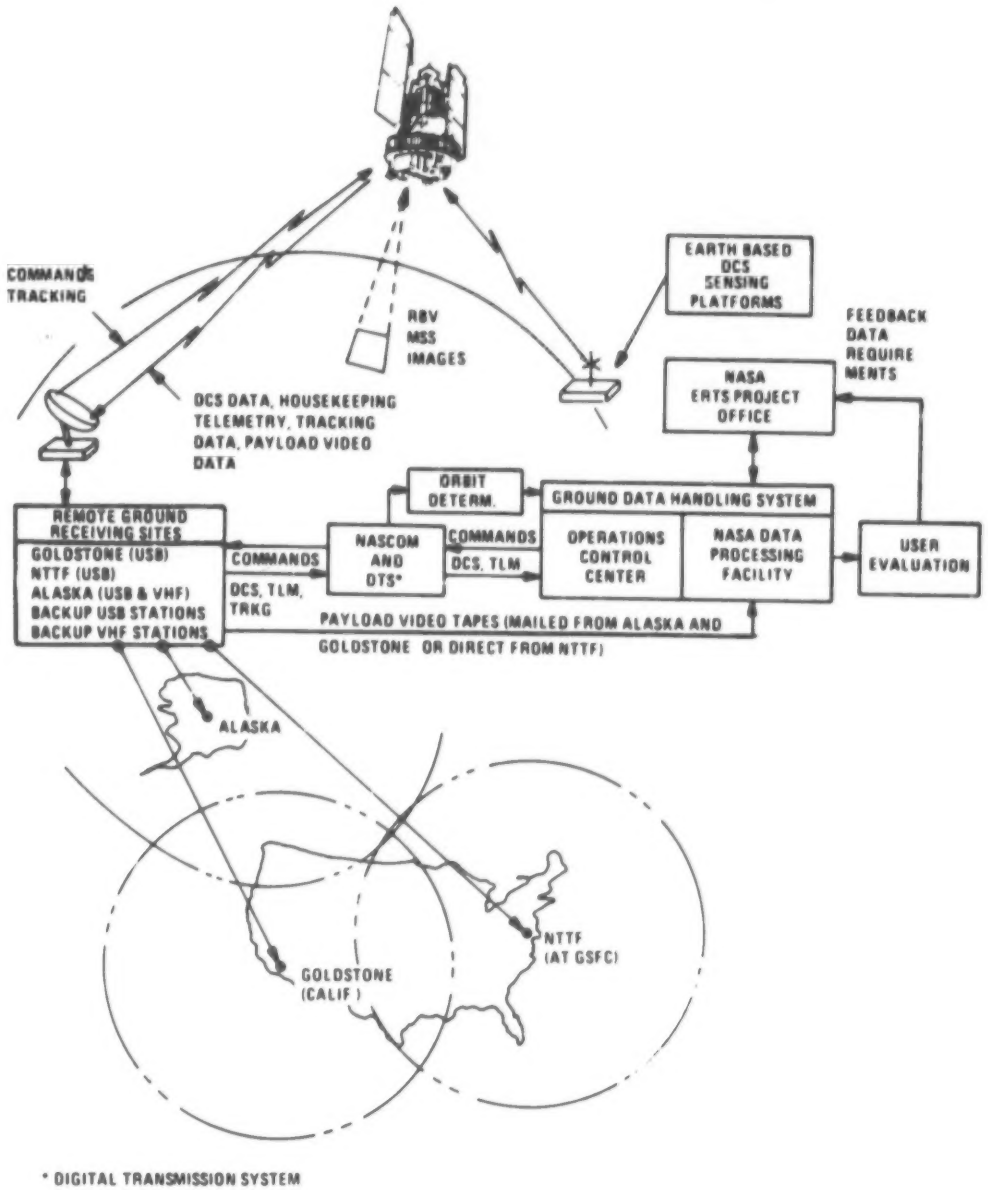

FIGURE 4-1 OVERALL ERTS SYSTEM

circular, sun synchronous, near polar orbit at an altitude of 494 nautical miles (900 kilometers). It circles the earth every 103 minutes completing 14 orbits per day. Complete coverage of any given point of the earth is achieved every 18 days. This provides accurate registration of any point within 20 nautical miles. A typical one-day ground coverage sweep is shown in Figure 4-2 for the daylight portion of each orbital revolution. The multi-spectral scanner is a line scanning device which uses an oscillating mirror to continuously scan as the observatory orbits. Six lines within the same band-pass are scanned simultaneously on each of the four spectral bands with each mirror sweep. The track of the spacecraft provides progression of the scanning lines. Optical energy is received simultaneously by an array of detectors in four visible spectral bands from 0.5 to 1.1 microns. In the ERTS B (1973 launch) a fifth band in the near-infrared (thermal) from 10.4 to 12.6 microns is provided. The outputs of the detector array are digitally encoded and transmitted to earth on a high speed data stream operating at 15 megabits per second. In addition to the multi-spectral scanner, precision color photography is available.

Figure 1-8 (page 1-16), an actual ERTS A photograph taken in August, 1972, shows ocean waste disposal operations in the New York Bight. A grid of latitude and longitude has been plotted to provide an accurate ground location reference.

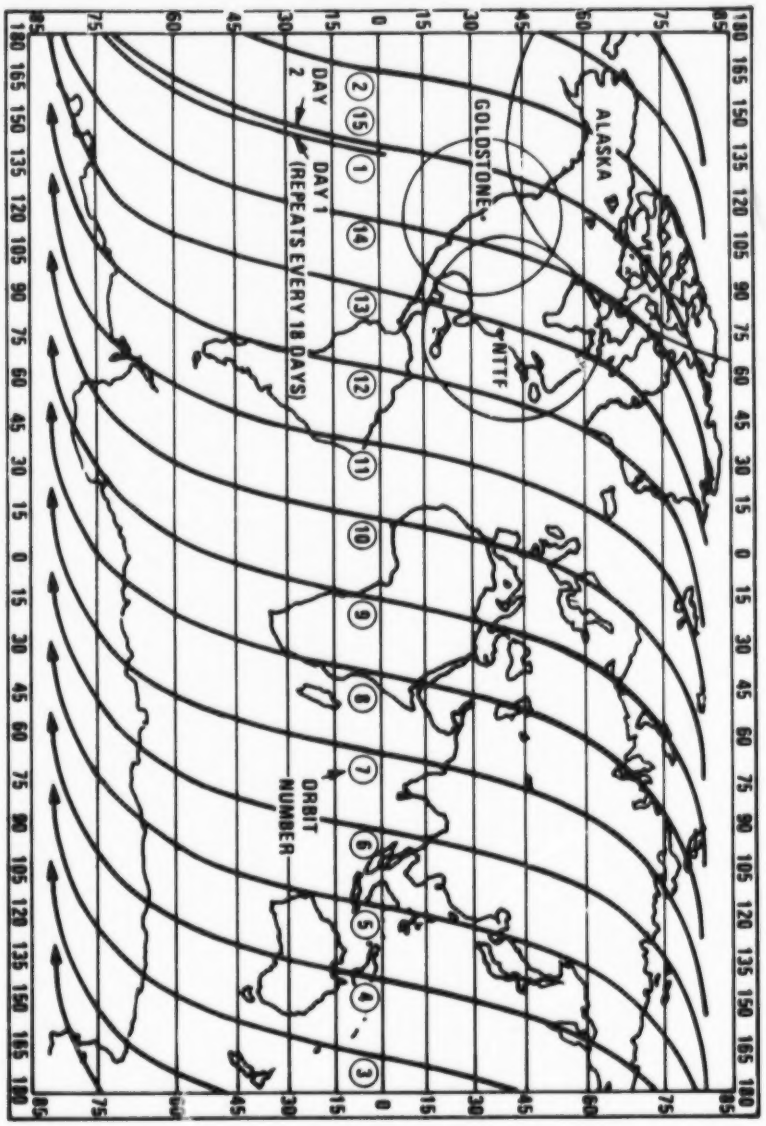

FIGURE 4-2 TYPICAL ONE-DAY GROUND COVERAGE SWEEP

No. 1 is acid waste. No. 2 is sewage sludge. The vessel (No. 1) started disposing of the material short of the actual disposal site. Figure 4-3 shows typical annotation provided by NASA on these photographs.

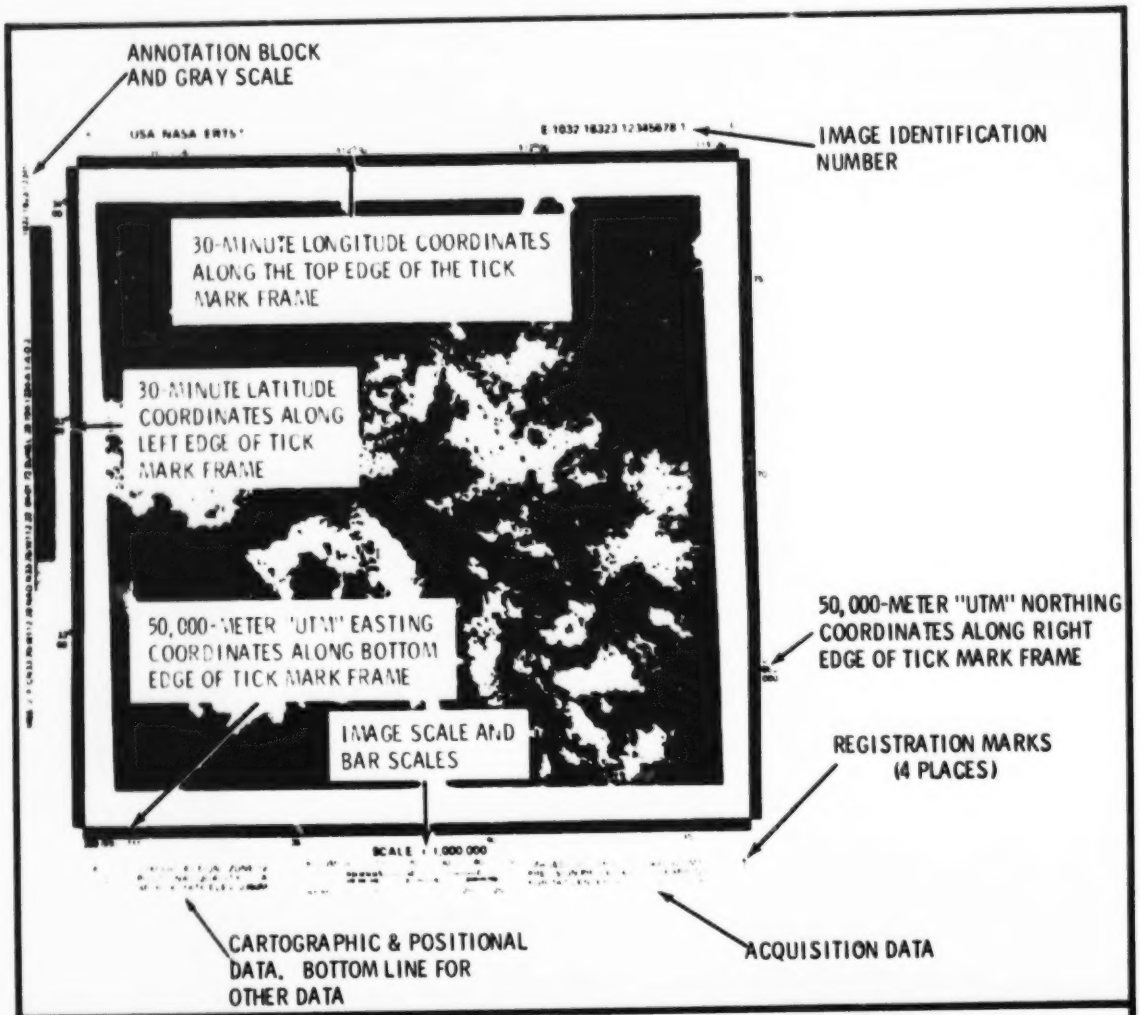
ANNOTATION BLOCK AND GRAY SCALE
IMAGE IDENTIFICATION NUMBER
30-MINUTE LONGITUDE COORDINATES ALONG THE TOP EDGE OF THE TICK MARK FRAME
30-MINUTE LATITUDE COORDINATES ALONG LEFT EDGE OF TICK MARK FRAME
50,000-METER "UTM" NORTHING COORDINATES ALONG RIGHT EDGE OF TICK MARK FRAME
50,000-METER "UTM" EASTING COORDINATES ALONG BOTTOM EDGE OF TICK MARK FRAME
IMAGE SCALE AND BAR SCALES
REGISTRATION MARKS (4 PLACES)
CARTOGRAPHIC & POSITIONAL DATA. BOTTOM LINE FOR OTHER DATA
ACQUISITION DATA

FIGURE 4-3 TYPICAL ANNOTATION

MONITORING

These illustrations show how a low cost management tool may be derived from data routinely provided by orbiting satellites. It is recommended that the Ocean Disposal Program establish a means of utilizing ERTS data to provide a spot audit of disposal operations. This would be done by checking the coordinates illustrated in the satellite photograph in a daytime group against the permits issued authorizing disposal that day. These tools would be particularly useful for spotting unauthorized dumping operations, dumping short of the authorized disposal area, and observing phenomena such as international disposal or disposal in the broad ocean area by foreign vessels that may reflect on U.S. disposal operations.